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Field Identification Manual for Ghanaian Timbers

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Abstract

Ghana is a nation rich in natural resources and tropical diversity, with forests covering approximately one-fifth of the country's total land area. To ensure that future generations of Ghanaians can enjoy the benefits of such a rich forest resource, Ghana has been enacting and enforcing laws intended to ensure that wood and wood-derived products are legally sourced. Compliance with and enforcement of these laws depend in part on the availability of technical or forensic expertise to validate claims of legality through the correct identification of timber during its extraction, processing, and grading. As part of a UNIDO-funded international partnership to improve timber tracking and timber forensics in the Ghanaian timber market, we present a wood identification manual for the most common commercial timbers of Ghana. This manual provides a field reference suitable for timber inspectors to conduct routine field screening of more than 100 timber species using macroscopic and physical identification features.

Keywords: Wood identification, tropical woods, Ghana, wood anatomy

Contents

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Background

This manual is one outcome of the Improving Sustainable Value Chains for Exports from Ghana program (SAP ID 100317), which is sponsored by the United Nations Industrial Development Organization (UNIDO). In 2016, Alex Wiedenhoeft made a study tour of the Forestry Commission's Timber Industry Development Division (TIDD) to asssess the state of timber forensics in Ghana and identify opportunities to build capacity and enhance TIDD's enforcement capabilities in the context of chain of custody managment for timber.

Objective and scope of the manual

The objective of this manual is to provide a field reference suitable for timber inspectors to conduct routine field screening of the common commercial timbers of Ghana. The manual covers a list of woods selected by TIDD and the Council for Scientific and Industrial Research-Forestry Research Institute of Ghana (CSIR-FORIG) that reflects priority species at the time of publication. As the timber market changes, it is expected that new species will take on new importance and the manual will need to be updated.

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1 | Wood identification and pattern recognition

Wood identification is a combination of art and science. Whereas the bulk of the wood identification section of this manual focuses on the scientific characteristics used to make accurate field identifications of wood, the contribution of the artistic component to the identification process should be neither overlooked nor understated. There is nothing specific you must do to train yourself in the artistic aspects of wood identification; your mind will do this automatically. The scientific aspects, on the other hand, are not as easy as the artistic portion of the process and will come only with diligent study, practice, and focus.

Wood identification is a process of pattern recognition. The patterns you will learn to recognize are patterns of wood structure; that is, specific cells in specific arrangements, many of which have specific terminology associated with them. At first, the terminology may be daunting, but with practice, the terms will take on meaning.

The process of identifying a wood specimen is a microcosm of the process of learning to identify any object. It is very similar to learning to identify anything—wood, birds, chairs, people. All these identifications are governed by the same processes of cognition resulting in recognition of a pattern (Fig. 1.1). Identification begins with careful observation, proceeds to mental comparison with similar woods, and then makes reference to a formal means of confirming an identification (e.g., reference to images in this manual or a small collection of correctly identified specimens).

Figure 1.1—We use pattern recognition in all aspects of our daily lives. All three of these objects are chairs, despite the differences in materials and design.

To be able to gather information about the characters in a piece of wood, you must understand the basic biology of wood (**Chapter 2**); use the correct tools (**Chapter 3**); be able to prepare the wood for observation (**Chapter 4**); and make careful observations of wood characters (defined and illustrated in **Chapter 5**). These characters are employed in an identification key (**Chapter 6**), and then from the key, the user is directed to species pages that provide more detailed information for confirming an identification (**Chapter 7**). Following the species description pages, the manual concludes with a reprise of the principles and process of identification, including a commentary on the limits of wood identification, a discussion on the need for scientific forensic expertise to combat illegal logging, a discussion on the formation of a reference wood collection, and additional information available to users in the robust and fascinating field of scientific wood identification **(Chapter 8)**.

Before the topics of using a hand lens, preparing wood for observation, and understanding the characters used in wood identification can be tackled, a general introduction to the biology of wood is needed. The woods in commercial trade in Ghana come almost exclusively from trees, so the discussion of wood biology is restricted to trees here, though much of what is presented is also true of shrubs and lianas.

The treatments of wood structure and wood identification in this manual are fairly rigorous and will provide the foundation necessary to identify not just the common woods found in Ghana but also tropical African woods. Additional references for wood identification are presented in **Chapter 8**. Therefore, if you wish to extend your knowledge of wood identification, the fundamentals in this manual will set you on a firm path.

2 | Basic wood biology—anatomy for identification

It is not a simple matter to organize the gross structure and biology of wood into an easy-to-understand text. It may be necessary to move back and forth between some concepts in this chapter in an effort to present a unified concept of wood structure for wood identification. Some sections of this chapter will be difficult to understand fully the first time through; if you read it a second time after thinking about the material, the once-unfamiliar concepts will be clearer.

2.1 Wood as a cellular material

Wood, like all living or once-living materials, is made from millions and millions of interconnected cells that form a larger structure, in much the same way your heart or liver is made of many different cells. Cells are the basic building blocks of larger organisms, and most of the identification sections of this manual focus on understanding different types, shapes, orientations, and groups of cells in wood. If the cellular basis of life is an unfamiliar concept, don't worry. The biological details of cells are not strictly necessary for wood identification, and what is necessary to understand is subsequently presented. It is our experience that most people find wood easier to understand and observe if they understand its origin as a biological material.

2.2 Two systems of cells in wood

Wood is made of two interlocking systems of cells, the axial system and the radial system (Fig. 2.1). The **axial system** is all the cells running up and down the trunk of the tree or along the grain of a board. The **radial system** is made up of rays, groups of cells running from the center of the tree out toward the bark. Rays and the radial system in general are less familiar to the casual observer of wood but are critical to understanding and identifying wood. Because tree trunks are generally round, the cells in the axial system are lined up in overlapping, curved layers. These facts are the basic structural principles of wood, and you can always come back to these basic facts to help yourself understand wood structure.

2.3 Functions of wood in a tree

Wood performs three major functions in the living tree, and by understanding these functions and the roles they play in the tree, we can better organize some of the anatomical details of wood. Common sense, a small dose of biology, and careful observation of wood will allow you to integrate the structure of wood with its function and remember more easily the names of cells and the patterns they form.

The most important function of wood to a living tree is the conduction of water from the roots up the trunk, along the branches, and out to leaves. If a tree fails at this task, it dies quickly. In wood, there are special types of cells that perform the conductive function, and it can be helpful to remember the conductive function of wood when learning to tell apart the various patterns of wood structure that we will see in this manual.

When most people are asked about the functions of wood, the first they think of is mechanical support, the strength of wood. Holding aloft the stem, branches, leaves, flowers, and fruits is indeed an important task for wood. All cells in wood play some role in its mechanical strength, but in some woods, there are cells specifically designated for a mechanical function. This is much like your own body; even

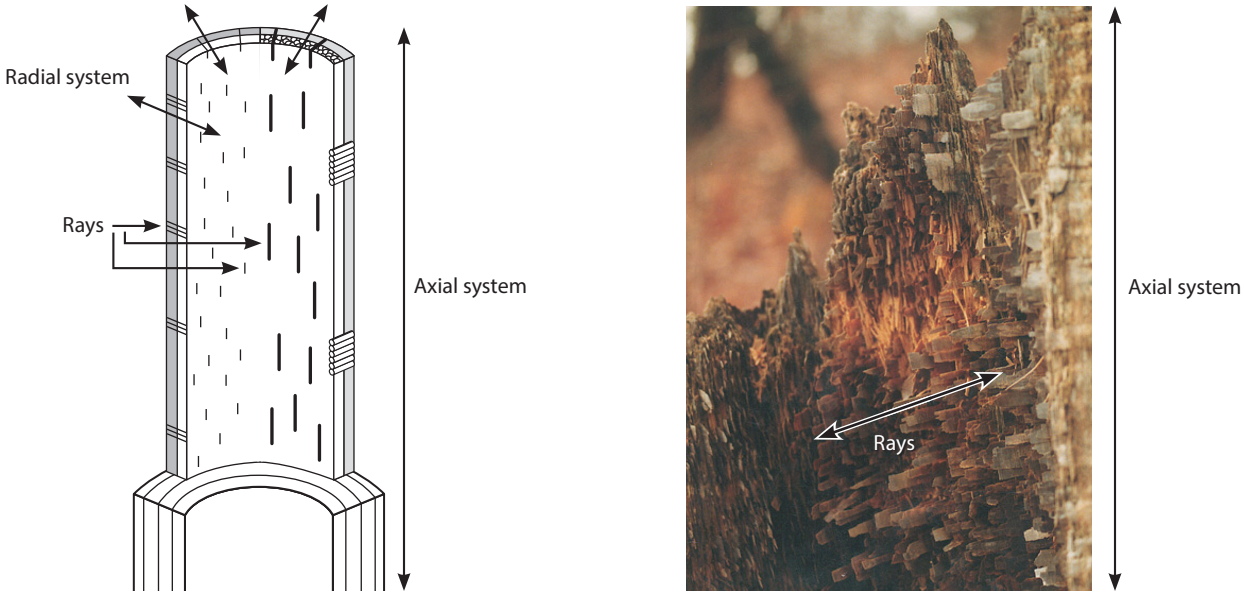


Figure 2.1—Axial and radial systems in wood. The diagram on the left shows a simplification of the axial and radial systems. The photograph on the right shows a decayed stump in which much of the axial system has been removed by fungi. The card-like tabs protruding are the rays of the radial system.

though your muscles, tendons, and ligaments are involved in supporting your body, the most important structural feature for mechanical support in a human is the skeleton.

The least obvious of the three functions of wood is the storage and synthesis of biochemicals. In the context of wood identification, storage is critically important because it is the storage function that gives wood its characteristic colors and odors. Color and odor occur as a function of the accumulation of chemicals in the central part of the trunk, whereas the outer layer of wood lacks them.

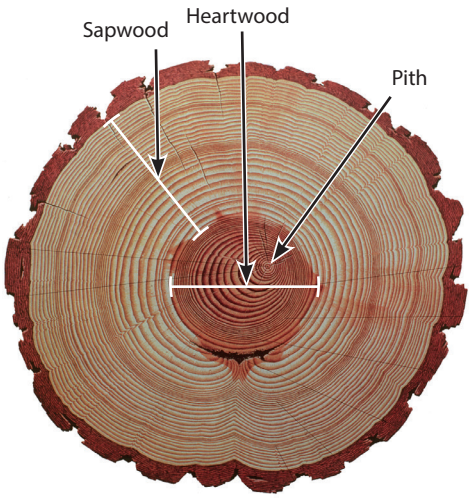


Figure 2.2—The end grain of a log. Bark surrounds the log. Inside this is the wood. The light colored wood is sapwood, the dark colored wood is heartwood. The small dot representing the center of the tree is the pith.

2.4 Heartwood, sapwood, and pith

A cut stump or a disc from a tree (Fig. 2.2) shows two basic domains in most woods: the central typically darkly colored (and sometimes odiferous) area called **heartwood** and the typically lighter colored outer strip of wood under the bark, the **sapwood**. In a living tree, water is conducted only in the sapwood; the heartwood does not participate in this function. Both heartwood and sapwood are involved in the mechanical support of the tree. For commercial timbers, generally only the heartwood is of value and the sapwood is not desirable. There is no appreciable structural difference between heartwood and sapwood; the difference is one of accumulated biochemicals in the heartwood. We can see that the tree, in addition to using different cells for different functions, also separates some functions in the wood (storage and conduction) at a level that can be easily seen with the naked eye. The center of the tree is called the **pith**; this is the tissue formed before the first wood was made by the tree.

2.5 Growth rings

Another way in which many (but not all) trees separate the three functions of wood is by forming discrete layers of wood with multiple components, each emphasizing a different function. These discrete units of wood are called growth rings (Fig. 2.3), and they represent the basic building blocks of wood structure that span the microscopic, cellular nature of wood and what can be seen with the naked eye. For those trees that form them, a growth ring is all the wood formed during one period of growth (whether that be the rainy season, the growing season, the time between flowerings, etc.) that can be distinguished by some anatomical characteristic from the wood formed during a different growth period. When you look at the end grain of a board or the cut end of a log or a stump, the concentric circles you can see are most likely growth rings. The portion of a growth ring formed at the beginning of the growing season is known as **earlywood**. It is found closer to the pith and can be specialized for the conductive function of wood. The portion of the growth ring formed later in the season is called **latewood**. It is found toward the outside of the tree and can be specialized for mechanical support. In most woods, there is no obvious separation of the storage function between the earlywood and latewood. Much more will be said about earlywood and latewood in Chapter 5, when the various kinds of growth rings are explored as sources of characters for identification. One last comment must be made here. The rays of the radial system appear as lines perpendicular to the growth rings when the end grain of a board or a stump is examined.

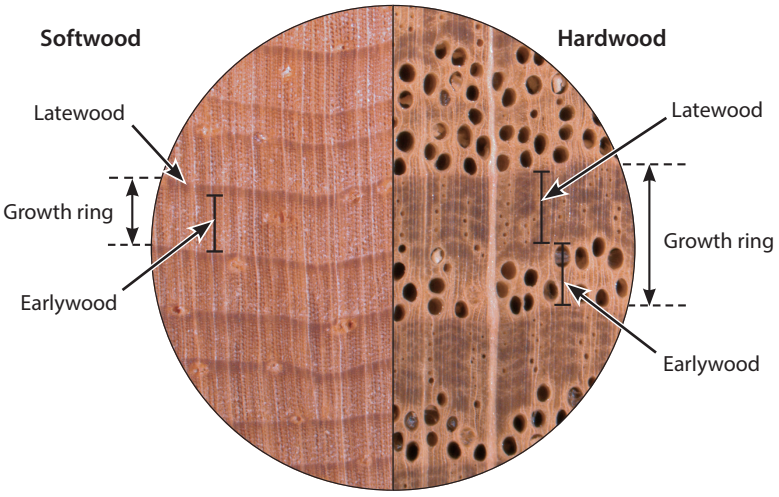


Figure 2.3—Growth rings in a softwood and a hardwood. Although the structure of these two woods is quite distinct, both have growth rings and the growth rings can be divided into earlywood and latewood.

2.6 The planes of section

The relationship between the cells of the axial system and the rays of the radial system, the round shape of a tree trunk, and the concentric nature of growth rings around the trunk combine to give us three primary ways to view a piece of wood. These three views are known as planes of section, and understanding them is one of the most difficult aspects of, but also absolutely necessary for, wood identification. Refer to Figure 2.4 as you read the following paragraphs.

There are two fundamental ways to cut wood: across the grain and along the grain. When we cut wood, whether to view it with a hand lens or to produce a board, the easiest cut to understand is across the grain. This is the transverse cut that loggers make when they fell a tree. This cut is perpendicular to the trunk and thus across the grain of the wood—across the axial system. The surface you see once this cut is made is the **transverse plane of section** or transverse surface, also known as the end-grain of the wood. On the transverse surface, we can see the curving nature of the growth rings and the way in which the rays of the radial system run perpendicular to that curvature; the rays appear as straight lines running from the center of the tree out toward the bark. To understand the other two planes of section, we must understand the relationship between rays, growth rings, and the round form of a tree trunk.

The second fundamental way to cut wood is along the grain; doing this produces a longitudinal cut and exposes a longitudinal surface. Although it is possible to cut along the grain in any orientation with respect to the rays and growth rings, the structure of wood shows us that there are two basic ways to cut it, either parallel to the rays or perpendicular to them. Because the rays and growth rings are perpendicular to each other, we can cut perpendicular to the growth rings or parallel to them. Not all woods, however, have obvious growth rings, so we will orient ourselves by speaking of the cut in reference to the direction the rays are oriented.

When we cut along the grain and parallel to the rays, we produce a radial surface or **radial plane of section**. This exposes the rays as lines running across the surface and is rarely used in the hand lens identification of wood. If a round piece of firewood is split exactly in half, from one side to the other through the center of the tree, the flat surface is a radial surface.

More important for our purposes is the longitudinal cut perpendicular to the rays—the **tangential plane of section**, or tangential surface. This exposes the cut ends of the rays and allows us to understand the size, spacing, and arrangement of the rays. This is the view of wood we would have if we could walk up to a standing tree and tear away the bark to view the wood.

We can use two analogies to clarify these ideas: geometry and apple pie (Fig. 2.4). In the geometry example, we draw a circle. Any line from the center of the circle to the edge of the circle is a radius of that circle. The radius in geometry is the ray in wood (and indeed is the source of the term "ray"). A line that touches a circle at one point is called a tangent line, and any radius of a circle that intersects with a tangent line is perpendicular to it at that point. The tangent line is parallel to the edge of the circle at that point. The edge of the circle represents a growth ring, the radius a ray, and thus if we are perpendicular to the ray, we are parallel to the growth ring. By extending this two-dimensional circle geometry to a three-dimensional cylinder and extending either the radius

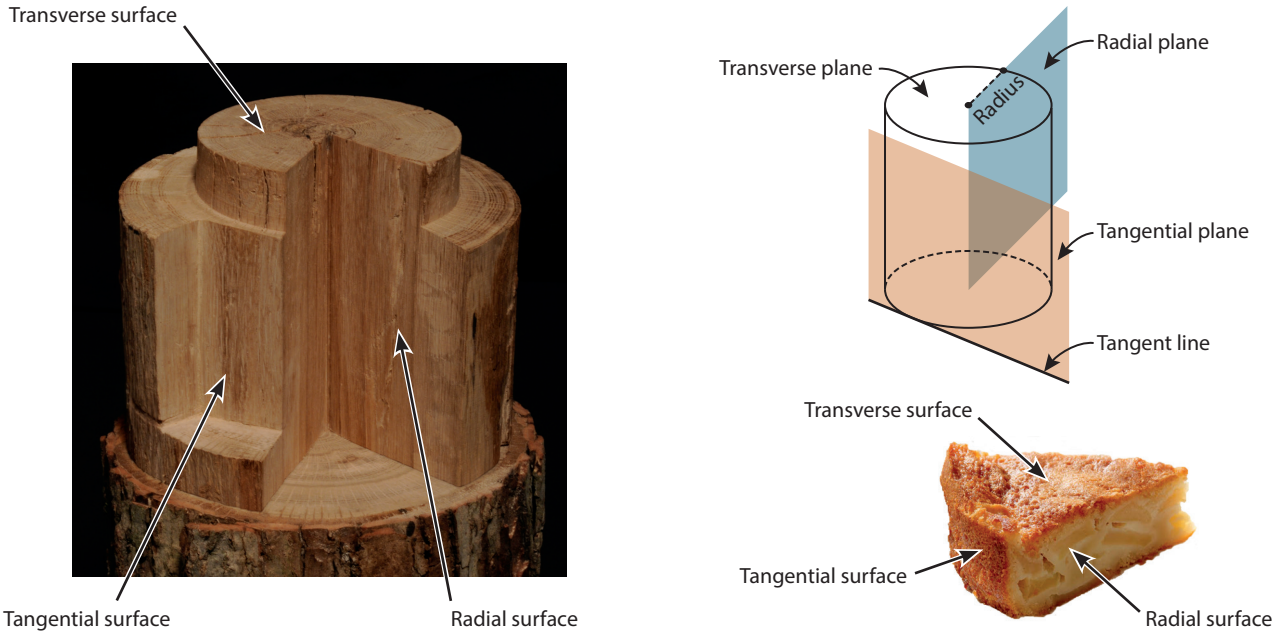


Figure 2.4—The planes of section illustrated three different ways. On the left is a photograph of a small log that has been cut across the grain to expose the transverse surface and cut along the grain to expose the radial and tangential surfaces. On the upper right is an illustration showing the relationship between radial and tangential planes in a simple cylinder. On the bottom right, a piece of apple pie shows the three planes of section. The top and bottom of the piece of pie represent transverse surfaces, and the cut sides represent radial surfaces. The curved outer crust of the pie represents the tangential surface.

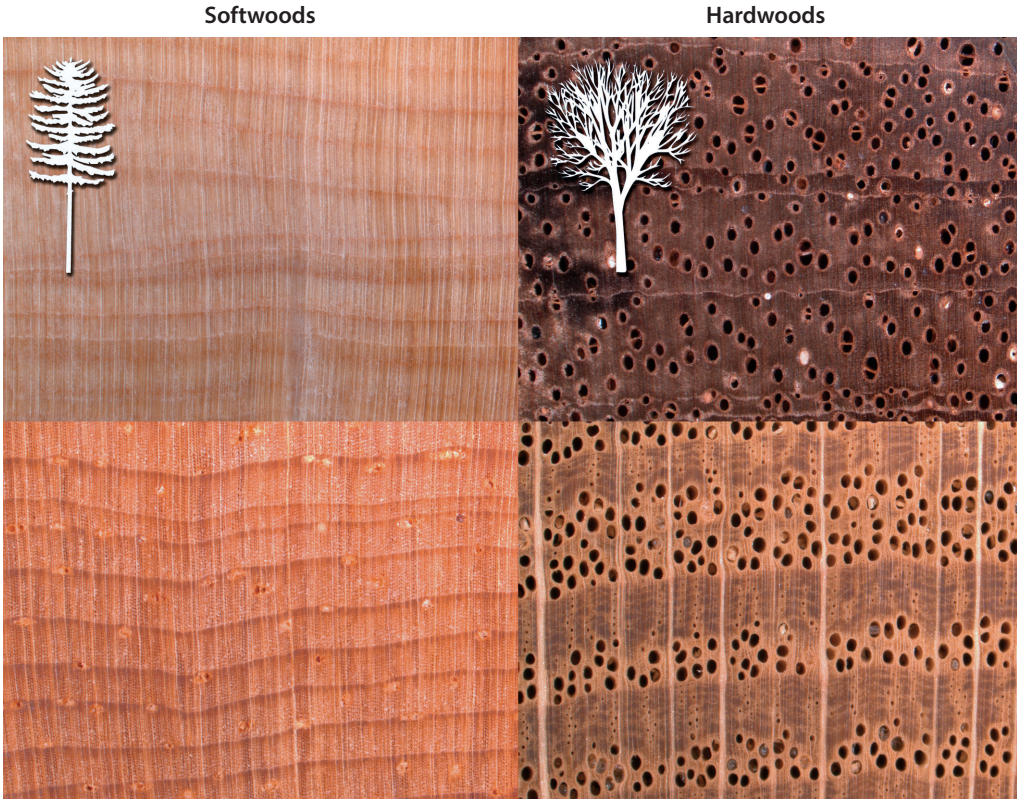


Figure 2.5—Two examples of the transverse surface of softwoods, and two examples of hardwoods. On the left, top and bottom, are two softwoods, as well as a silhouette of a generic softwood tree. On the right, top and bottom, are two hardwoods, as well as a generic hardwood silhouette.

or the tangent line up and down the cylinder, we produce a radial or tangential plane of section, respectively.

The second analogy is perhaps more accessible. If we start with a freshly baked, delicious apple pie, we have a round object. When we cut the pie to share it with our family, we make cuts from the edge of the pie into and across the center until we have a number of wedge-shaped pie pieces. Each pie piece shows all three planes of section. The top and bottom crusts of the pie are the transverse surfaces. The exposed apple filling along the two cut edges are radial surfaces, and the outer, curved portion of crust that was against the pie pan is a curving tangential surface.

We identify people we know mostly by facial characteristics, and hand-lens wood identification uses primarily features on the transverse surface; thus it can be said to be the "face" of wood. For this reason, any reference to the appearance of a character will be on the transverse surface unless otherwise stated. We will do little or nothing with the radial and tangential surfaces. One way to perfect your understanding of the planes of section is to make careful three-dimensional drawings of the relations between the planes without looking at the figures. When you can explain the planes of section to someone else, your understanding of the material is complete.

2.7 Softwoods and hardwoods

The topics we have covered thus far in this chapter are true of all woods in the manual, regardless of species or origin. The remainder of the chapter is devoted to drawing some fundamental distinctions between different kinds of woods and understanding the anatomical and cellular bases for their differences.

There are two fundamental types of wood, depending on the type of tree that made the wood: softwoods and hardwoods (Fig. 2.5). Softwoods come from needle-leaved and cone-bearing trees, such as pines, spruces, firs, cedars, and podocarps. Hardwoods come from broad-leaved and flower-bearing trees, such as emire, mansonia, ofram, and wawa. The distinction between hardwoods and softwoods is thus a botanical one, and in the forest, this can most easily be seen by differences in external characteristics such as leaf shape, the nature of the reproductive structures (cones vs. flowers), and the architecture of the tree itself. In addition to these external features, the cells that comprise the wood of softwoods and hardwoods are quite different structurally. Thus, hardwoods and softwoods are easily distinguishable from each other in the process of wood identification.

Though softwoods and hardwoods are structurally distinct (as will be explained in detail below), both are still wood and thus serve the same three functions for the tree. They have axial and radial systems, heartwood and sapwood, and growth rings and can be cut to produce transverse, radial, and tangential planes of section. Many species of both softwoods and hardwoods divide the labor of the three functions according to the kinds of cells in each and the ways in which the growth rings are formed by the tree. Cells in wood are either dead at functional maturity (one type of cell in softwoods, two types of cells in hardwoods) or alive at functional maturity. In both softwoods and hardwoods, the living cells are called parenchyma cells. Parenchyma

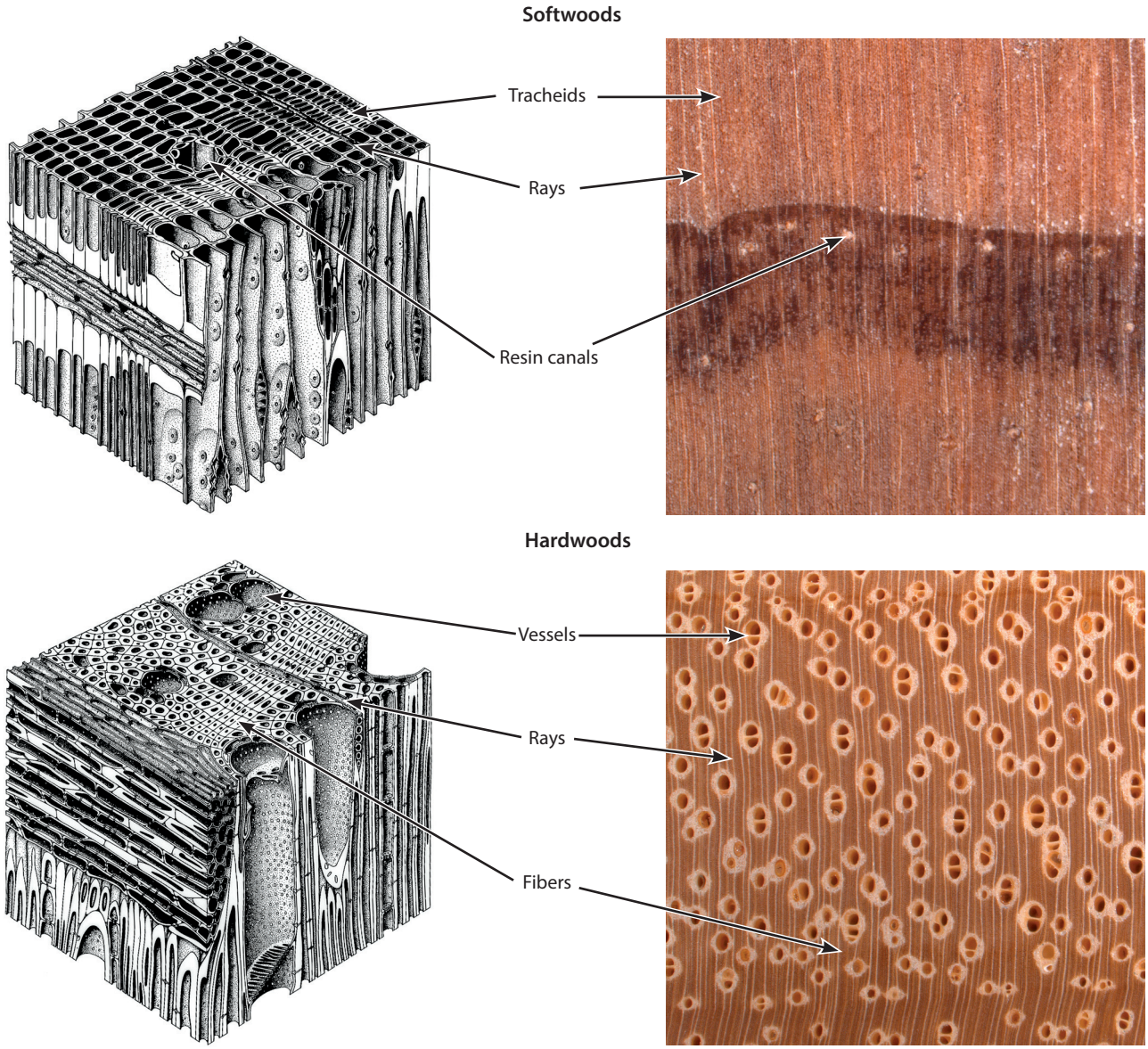


Figure 2.6—Anatomical differences between softwoods (top) and hardwoods (bottom). Softwoods are composed mostly of tracheids, which can be thin-walled in the earlywood and thick-walled in the latewood, and rays running vertically in the image on the right. The illustrations on the left show more detail and are drawn at a higher magnification than the hand-lens view of the transverse surface on the right. Shown in both images are resin canals. Hardwoods are structurally more complex than softwoods, with vessels, fibers, axial parenchyma, and rays. The vessels are the dark holes scattered throughout the wood. The rays are the lines running vertically in the image. The axial parenchyma in this wood appears as light-colored, round halos around the vessels. The individual fibers are too small to be seen, but together form the brown tissue in which the other cells are embedded. Note that in this hardwood, there is no clear distinction between earlywood and latewood. This is discussed in more detail in Chapter 5.

cells can be a part of the axial system of both softwoods and hardwoods and make up virtually all the cells in the radial system (that is, rays are composed of parenchyma cells).

2.7.1 Specific cellular anatomy of softwoods

The cellular anatomy of softwoods is simple compared with that of hardwoods (Fig. 2.6). The axial system is formed predominantly of one kind of cell, the **tracheid**, which serves the tree both in the conduction of water and in mechanical support, and is dead at functional maturity. Viewed with a hand lens, tracheids appear as small boxes or rectangles. In species with obvious growth rings, the earlywood tracheids are typically thin-walled and the open spaces in the cells, the lumina, can be seen as dark centers. In such species, the cell walls of the latewood are much thicker, and often the lumina of the cells cannot be seen. The second and less prevalent cell type in the axial system of softwoods is axial parenchyma, which appear as either scattered solitary cells or forming special structures called resin canals. Resin canals are discussed later as an important character for the identification of softwoods. The radial system, as in all woods, is composed of ray parenchyma cells. It is not possible to see individual softwood ray parenchyma cells with a hand lens, but the rays

they compose are faintly visible as straight lines running perpendicular to the growth rings. Rays in softwoods are generally only one cell wide, and this is why they appear only faintly.

2.7.2 Specific cellular anatomy of hardwoods

The cellular wood anatomy of hardwoods is more complex than that of softwoods (Fig. 2.6) because there are three main cell types in the axial system: vessels, axial parenchyma, and fibers.

Vessels are the characteristic cell type of hardwoods; all hardwoods in the manual have vessels, and no softwoods in the manual have them. Thus, the presence of vessels is definitive proof that a wood is a hardwood. Vessels are dead cells specialized for water conduction and are generally much larger and rounder than tracheids in softwoods. They appear as round pipes or holes in the wood, and understanding the variation in their structure, size, distribution, and relative proportions is a major component of hardwood identification.

Axial parenchyma cells in hardwoods are, as with all parenchyma cells, living cells when functioning in the tree. Axial parenchyma in hardwoods is much more common, and its distribution much more complex, than in softwoods. Axial parenchyma is generally visible with a hand lens when it occurs in groups of many parenchyma cells. It is generally seen as a lighter colored tissue compared with the other cells in the wood. Hardwoods present a great range of axial parenchyma patterns and abundance, ranging from barely visible with a microscope to easily seen with the naked eye. Along with variations in vessel characteristics, the amount, distribution, and type of axial parenchyma present in a wood is one of the major sets of characters used in hardwood identification.

Fibers are dead, thick-walled cells and are not usually individually visible with a hand lens, but in any given hardwood, groups of fibers usually form a large percentage of the visible cells. Though it is an awkward way to describe their appearance, fibers are most easily seen and understood by subtraction; if you are looking at cells of the axial system that are not vessels or axial parenchyma, they are fibers.

The radial system of hardwoods is composed of **ray parenchyma**, and as with softwoods, it is usually not possible to discern individual ray parenchyma cells. Unlike softwoods, hardwoods have a tremendous variety of ray widths, ranging from rays one cell wide and barely visible (as in softwoods) to rays more than 60 cells wide and easily seen at a distance with the naked eye.

2.8 Understanding scientific names

This manual will reference woods using the species' scientific names, rather than their local or trade names, though they will be included when available. The reason for this is that the same species can have one or more local or trade names in every region in which it grows. It would be confusing to use all the local names from all regions every time we refer to a species. Adding to the confusion, the same local name can be applied to completely different woods in other regions. The confusion this would create would easily exceed the burden of learning to use scientific names.

Scientific names are made of two words, a genus name and a specific epithet. Both the genus and the specific epithet are italicized or underlined when printed. The genus name is the first word of the two and is always capitalized. The specific epithet is the second word of the two and is not capitalized. Scientific names give you information about the species in question in much the same way that your name gives others information about you and your relations. For example, the name Kofi Bonsu: Bonsu is the surname, and because of traditions in Ghana, this gives you information about the surname of the father. Kofi is the given name, and this distinguishes him from other members of his family, none of whom are named Kofi. In scientific names, the genus name (or genus) is like the surname; it designates the group to which the species most closely belongs. The specific epithet is like a given name (first name), distinguishing that species from all others in the genus.

For African mahogany, the scientific name is *Khaya ivorensis.* The word *Khaya* is the genus name, and the word *ivorensis* is the specific epithet. Three other species in the genus *Khaya*, *K. anthotheca*, *K. grandifolia*, and *K. senegalensis*, appear in this manual. Note that the genus was abbreviated by placing a period after the first letter and omitting the rest of the word. This is done only after the genus has been spelled out already and is a convention that saves space. Note also that it did not say "There are three other species in the genus *Khaya, anthotheca*, *grandofolia,* and *senegalensis*." Although it would have been clear that the subject was a species of *Khaya,* in other cases, such a shortcut might lead to confusion in much the same way as using only the given name, Kofi, which is not specific enough to distinguish him from all the other people with that given name. If the surname were a common name such as Smith, there would probably be hundreds or thousands of other people named Kofi Smith in the world. Such confusion is prevented in scientific names by a simple rule; the same combination of genus name and specific epithet may not be used to refer to more than one species. Thus, there is only one *Khaya ivorensis* in the world, and its scientific name can never be confused with that of any other species.

Learning to use scientific names correctly empowers you to communicate precisely. Sometimes the group to which a wood belongs is between the level of species and genus. This is common in genera (the plural of genus) with many species or in genera in which the wood of different species is dramatically different. For example, the genus *Celtis* has many species scattered across West Africa and different groups of species have different anatomical characteristics. *Celtis zenkeri* is a species that belongs to the red (Esa-kokoo) group. Its identity could be reported as *Celtis* sp., red (Esa-kokoo) group, because though it can be determined that it is not a member of the white Celtis (Esa-fufuo) group, the exact species within the red Celtis

(Esa-kokoo) group cannot be determined. There is no special or convenient scientific word to use, so the scientific name is combined with additional information written in plain language to indicate the proper level of specificity in the identification.

3 | Correct use of a hand lens

Fig. 3.1—A hand lens has two main parts, the lens and the housing.

A hand lens is a powerful tool for the identification of wood, but like all tools, it must be used correctly to take full advantage of its powers. The hand lens has two main parts (Fig. 3.1), a lens that magnifies the object of interest (generally we use 10× or 14× lenses in wood identification; a 14× lens is recommended for use with this manual) and a housing to hold and protect the lens. Unlike a microscope that is able to focus at different distances depending on the specimen and the configuration of the various lenses, thus requiring much adjusting, a hand lens has a fixed focal length. There is only one distance between the lens and the object that will produce a sharp image. This distance is easily found by examining a coin or other familiar object with the lens but is generally only 1–4 cm between the lens and the specimen. Most hand lenses have no "front" or "back" to them; you can look through either side of the lens at a specimen.

Because there is only one distance between the lens and the object that will produce a good image, the remaining variable is the distance between the lens and your eye. For the best results, the hand lens should be placed as close to your eye as possible (Fig. 3.2); it is common for your eyelashes to brush against the lens when it is used correctly. Many people find this unnatural at first, but it is essential that this close distance be used. Before trying to look at a specimen of wood, use the lens to examine common objects: the cloth of a shirt, the print in this manual, a fingernail, or other things of interest. Force yourself to keep the lens close to your eye, and practice adjusting the distance between the lens and the object. At first, it will probably be helpful to close your other eye, but after a few minutes of examining common objects, practice using the lens with both eyes open. Although this can be difficult for many people, it is a good skill to practice because it will reduce eye strain.

It can be difficult to ensure that enough light reaches the specimen when using a hand lens; your hands and head will block light and shade the specimen (Fig. 3.3), making it hard to observe details. It is tempting to move the lens away from your eye at this point so that more light falls on the object. Do not do this. Instead, you must reorient your body so that light falls on the specimen. Sometimes this process of finding sufficient lighting requires you to turn to a different angle, bend at the waist, or take other action to find ample light. If you are identifying wood in the field, it may be necessary to remove a small specimen and move out from the shade of the structure into the direct sunlight. Although this may seem like a minor point, taking pains to secure good lighting has several benefits. First, it allows the hand lens to perform to its full capacity as a tool. Second, it ensures that the object, ultimately an unknown wood specimen, can be observed in sufficient detail to permit identification. Last, it reduces eye strain, allowing you to gain more experience and practice wood identification more comfortably.

Figure 3.2—Using a hand lens to observe a wood specimen. On the left, the distance between the lens and the observer's eye is much too great, but the distance between the lens and wood specimen is correct. The top photo in the center shows the correct distance between the lens and the wood specimen. The bottom photo in the center shows the correct distance between the lens and the eye. The photograph on the right shows the correct distances between the lens, the specimen, and the eye.

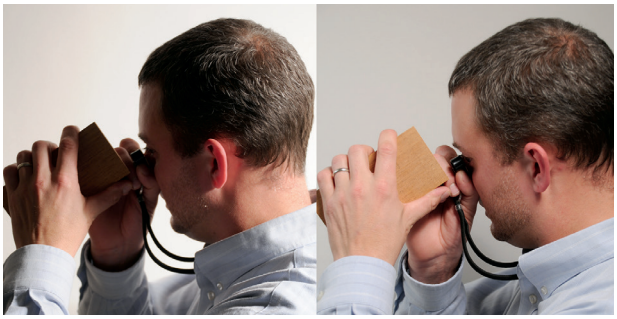


Figure 3.3—On the left, the observer's head is blocking the light, and the specimen cannot be observed properly. On the right, the observer is allowing light to fall on the specimen to ensure accurate observation.

4 | Wood specimen preparation for hand lens observation

The single most difficult physical skill involved in wood identification is producing a smoothly prepared surface for observing anatomical features. This skill must be practiced patiently; it takes time to become proficient at this task. Producing a cleanly cut surface is also the only appreciably dangerous aspect of wood identification with a hand lens; the tools used to cut the wood are necessarily sharp, and injuries from minor cuts to major lacerations can result from carelessness, fatigue, or poor technique. Safety must always be the first priority, followed closely by the secondary importance of making a serviceable cut of the wood. Because this skill is both necessary and inherently dangerous, patience and prudence must be exercised while learning. Before trying to cut a specimen of wood with these techniques, please read and understand this entire chapter.

4.1 The principles of cutting

A few basic principles apply to cutting any material, and you are probably already familiar with them from everyday experience. The first and most important principle is the idea of drawing the edge of your cutting tool across the surface you intend to cut. One of the easiest ways to think about this is in terms of slicing a tomato (Fig. 4.1): if you try to push the edge of a knife straight through the tomato, even the sharpest knife will crush the tomato rather than make a nice slice (Fig. 4.1a). If you saw back and forth many times with the knife edge as you slice the tomato, you produce ragged and uneven slices (Fig. 4.1b,c). The best technique is to draw the edge of the knife a single time through the tomato as the downward motion is applied (Fig. 4.1d). This gives you the maximum cutting ability of the edge of the knife and produces clean, even slices (Fig. 4.1e). If you place the edge of the same knife on your thumb with slight pressure, it will not cut you (Fig. 4.1f). If you slide the edge of the knife along your thumb under the same pressure, you will be cut. When we cut wood to view it with a hand lens, we must draw the edge of the cutting tool across the area we are preparing; no other technique will suffice.

A second principle of cutting has to do with the relationships between the blade and the material to be cut. Harder materials generally require a steeper cutting angle than softer materials (Fig. 4.2). Harder materials generally require sturdier blades to cut them as well. For example, you can shave hair with a thin razor, but to cut copper wire, you need much thicker wire cutters. To prepare wood for observation with a hand lens, there are two basic cutting tools, the utility knife and the razor blade (Fig. 4.3); the utility knife is used for most woods. The harder the wood, the steeper the cutting angle, and the softer the wood, the shallower the angle (Fig. 4.2). With very soft woods, the cutting angle needed is smaller

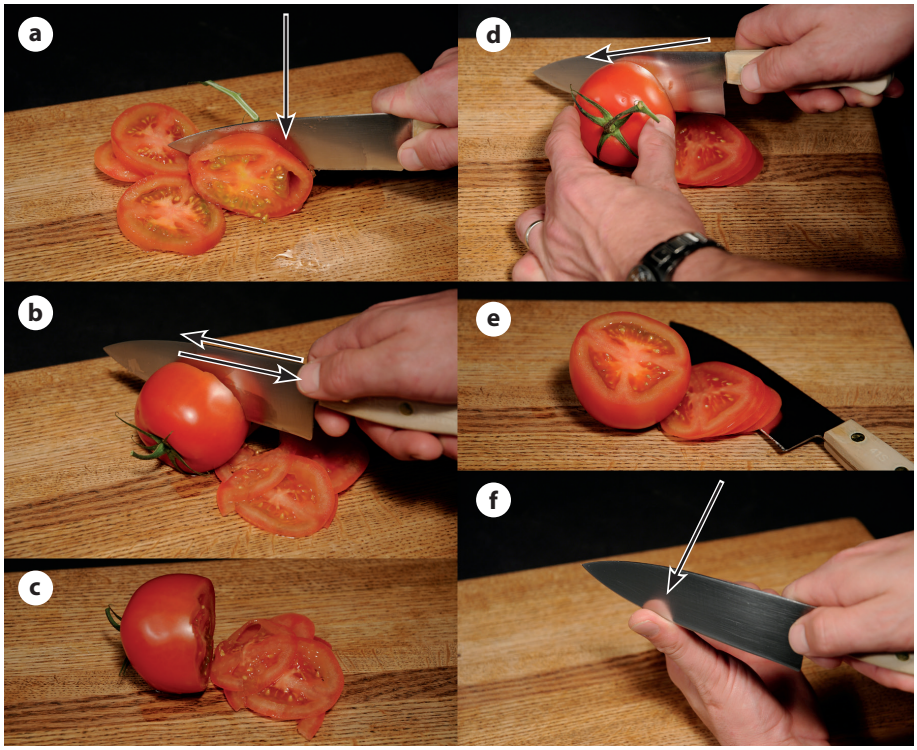


Figure 4.1—Slicing a tomato illustrates the principles of cutting wood: (a) Pushing a sharp knife downward through a tomato crushes it. (b) Sawing back and forth through the tomato makes uneven slices (c). (d) Passing the knife through the tomato with one even stroke maximizes the cutting ability of the blade and produces clean slices (e). (f) Pushing the blade into the thumb does not cut the skin.

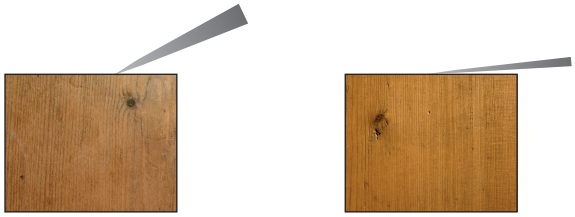


Figure 4.2—Illustrations of cutting angles for hard, dense woods and softer woods. On the left, the angle of the knife to the wood is high because the wood is dense and the thicker blade is needed. On the right, the angle of the knife is low because the wood is light and soft and the thinner, sharper blade is needed.

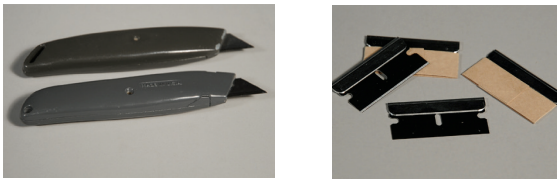


Figure 4.3—Two basic tools for cutting wood. Utility knives (left) are the preferred tool and will make clean cuts of all but the softest woods. Razor blades (right) make clean cuts of softer woods, but their edge is too fragile to cut denser woods.

than the bevel angle on the edge of the utility knife, and thus we switch to a thinner blade, the razor blade. This thinner blade and sharper edge allows a shallower cutting angle and produces a better surface on the specimen. For most of the woods in this manual, a razor blade would not be strong enough to cut them and the utility knife is the better tool.

4.2 Holding the knife

To cut wood safely and effectively, it is necessary to hold the knife correctly. The safest and most powerful method of cutting wood might contradict what you have been told about using a knife. Most people are taught to cut away from themselves, to minimize the chances of a laceration. For surfacing wood specimens, you will cut toward yourself, but you will do it in a controlled and failsafe way that, if done correctly, makes it impossible to cut yourself. This is accomplished by using the correct knife grip (Fig. 4.4). Begin with an open hand, thumb extended, fingers held loosely together. Lay the knife in the palm of your hand such that the base of the blade (where it joins the handle) is close to but not in contact with the web of skin between your thumb and index finger, with the edge of the blade facing your thumb (Fig. 4.4a,b). If the edge is extended too far from your hand, you will lose the force needed to make a good cut (Fig. 4.4c); if the edge of the blade is touching your skin, you will cut yourself badly (Fig. 4.4d). Now, taking care that the knife does not shift either closer to or farther from the web of skin between the index finger and the thumb, close your fingers firmly over the handle of the knife. Wrap your thumb loosely over your fingers. This is the basic grip (Fig. 4.4b). When it is time to cut a specimen, you will use your thumb as a fulcrum to pull the knife through the specimen by closing your fist tightly.

DO NOT try to cut a wood specimen yet

4.3 Holding the specimen

With the knife occupying your dominant hand, your other hand must hold the specimen. There are two simple rules for holding the specimen. First, you must grip the specimen quite firmly, as it takes considerable force to produce a cleanly cut surface on a wood specimen. Too loose a grip, and the specimen will sail from your grasp and you might cut yourself. Second, keep all parts of your hand away from the path of the blade; do not in any way hold the specimen near the area you intend to cut (Fig. 4.5). All body parts must be well away from the cutting area or shielded on the leeward side of the specimen to have a safe and effective grasp on the specimen.

DO NOT try to cut a wood specimen yet

4.4 Choosing a specimen

When working in the field, you will probably not have much control over the size and shape of wood specimen you must identify, but when you are practicing these techniques, wise choice of specimens is critical. Select a specimen that is approximately the length and width of your hand. The thickness of the specimen should be between 1 and 3 cm; any thinner and it may flex or break, any thicker and it will be difficult to hold firmly.

DO NOT try to cut a wood specimen yet

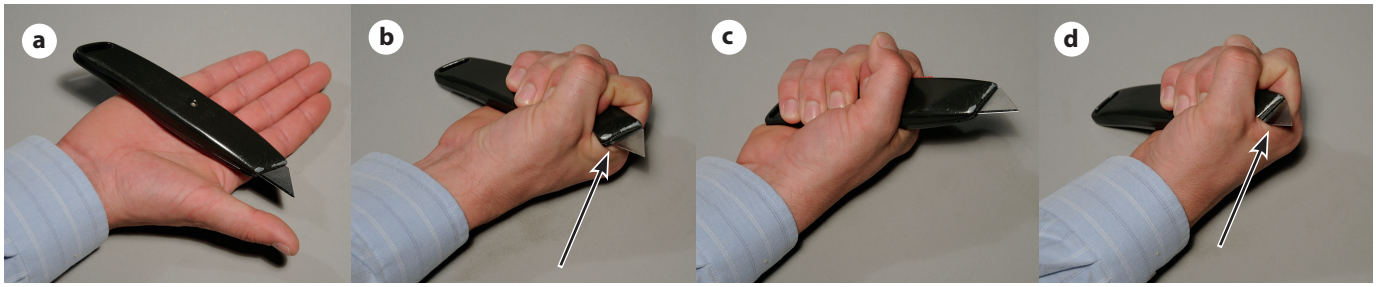


Figure 4.4—Holding the utility knife safely. (a) Begin with an open hand, and orient the utility knife as shown. (b) Close the fingers and wrap the thumb over the fingers; this is the basic grip. Note that the base of the blade is not touching the web of skin between the index finger and the thumb (arrow). (c) The distance between the blade and the hand is much too large, and it will be difficult to have the strength to make a clean cut of a wood specimen. (d) The blade of the knife is in contact with the skin between the index finger and the thumb (arrow) and will cut the skin.

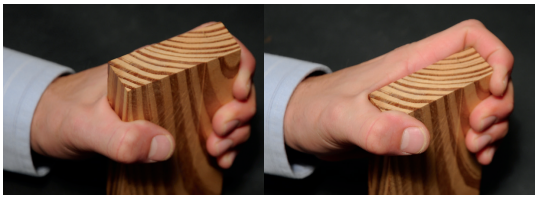


Figure 4.5—The correct grip for holding a specimen for cutting (left). Note that the fingers and thumb are below the top of the specimen and will not be cut. On the right, the specimen is held with the fingers and thumbs in a way that will result in injury when the specimen is cut.

4.5 Orienting the specimen

In addition to questions of knife angle outlined in the section on the principles of cutting, you must also orient the edge of the knife relative to the specimen to produce a precise plane of section. If you are cutting a transverse surface, the edge of the knife must cut through the specimen perpendicular to the axial system, not merely perpendicular to the surface of the specimen (Fig. 4.6a,b); if you are out of plane by more than one or two degrees, the anatomy of the wood will take a stretched appearance and not be interpretable (Fig. 4.6c,d). Likewise, if you are making a tangential surface, the edge of the knife must be perpendicular to the rays as seen on the transverse surface, and the edge must cut evenly along the grain (and not across at an angle). In either case, careful orientation of the specimen and the knife is critical.

Consider a section of plastic pipe: if you make a true transverse cut through the pipe, the end of the pipe will appear as a perfect circle, but if you cut at some angle through the pipe, the opening in the end of the pipe will be elliptical (Fig. 4.6e). Because the cells in wood are essentially tiny pipes, the orientation of the knife edge relative to the structure of the wood is critical.

It is important to note that your job is to orient the knife edge relative to the direction of the cells in the wood, not relative to the cut surfaces of your block. It is common for wood specimens to be cut imperfectly; what appears with your naked eye as a transverse surface may in fact be 5 or 10 degrees out of plane.

DO NOT try to cut a wood specimen yet

4.6 Making the cut

If you have followed the critical directions for holding the knife and the specimen, which you must, you now need only be mindful of the position of your thumb on the knife hand. It should be pressed to the near side of the wood specimen, well below the top of the specimen so that it is physically impossible for you to slip and cut yourself.

Review the instructions for holding the knife and the comments about the primacy of safety before continuing.

You now have a knife, a wood specimen, and an initial sense of what you are trying to accomplish, and you know where to put your fingers so that you end the day with as many as you began it. The next question is where on the block should you cut? Because you are using your thumb as a fulcrum for the cutting motion and protecting it away from the path of the knife, the best way to maximize the force in your cut is to cut the corner nearest your thumb. This is true for all three planes of section. By keeping the blade closer to your thumb, your hand doesn't need to stretch far and you can have maximum leverage. To cut, you draw the edge of the knife through the wood, starting your cut with the base of the blade at the farthest point from your thumb, and pulling the knife toward your hand by firmly making a fist (Fig. 4.7). The exposed portion of a utility knife blade is approximately 2 cm long, so your total cutting motion as you draw the knife through the wood will only be maybe 3–4 cm in length, because of the angle of the blade and the way you pull it through the specimen. This is not a large motion, and it should be done smoothly and confidently. You will make a comparatively small surface, especially at first. This is acceptable because the surface is meant to be viewed with your hand lens, and this will make the area seem much larger.

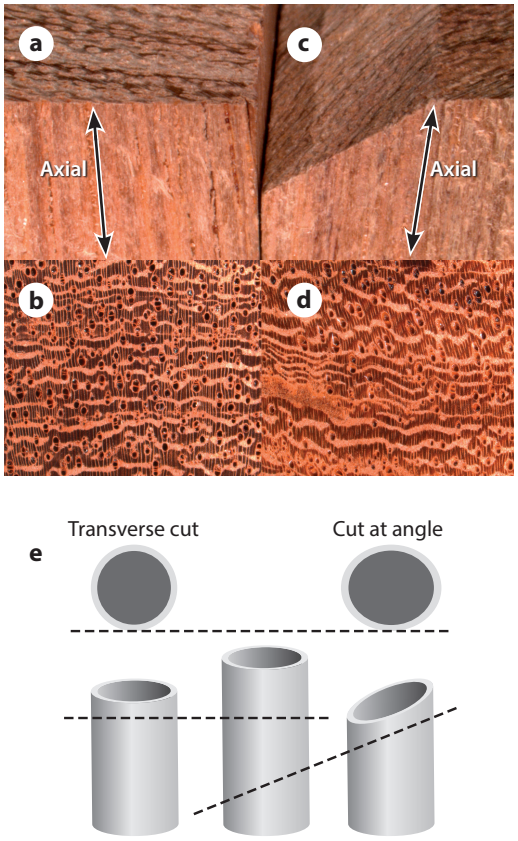


Figure 4.6—When cutting a transverse surface for observation with a hand lens, the cut must be oriented relative to the cells of the axial system, not relative to the surface of the specimen (a). A good cut is perpendicular to the axial system and produces a surface in which the anatomical features appear normal (b). Cutting at an angle to the axial system produces a surface in which the anatomical features appear stretched (d). A perpendicular (left) and angled (right) cut through a pipe (e). The perpendicular cut produces an accurate representation of the circular shape of the pipe, whereas the angled cut produces an oval representation.

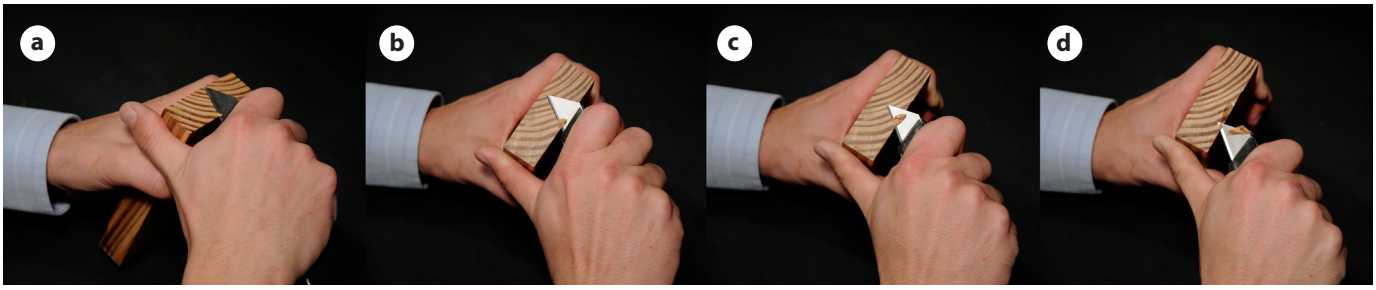


Figure 4.7—Safely making the cut. (a) The grip of the specimen and knife and the placement of fingers and thumbs. (b–d) The progress of the knife through the specimen. The cut begins at the base of the knife (a, b) and the knife is pulled through the specimen, drawing the edge along the wood as the cut is made. Note that at the end of the cut, the tip of the blade is all that is in contact with the wood (d). In all images, the thumb of the knife hand is below the top surface of the specimen (shown clearly in a).

The first few times you try this, you will almost certainly fail. As long as your failure does not involve blood, it is actually a success, as failure is a part of the learning process. If your knife angle is too steep, the blade will bury in the specimen. If it is too shallow, the edge of the knife will not bite into the wood. Practice thoughtfully, rereading the chapter as needed to understand what went wrong. If the edge of the utility knife begins to feel dull, replace it. As your technique improves, blades will last longer, but in the beginning you will use several blades in a few hours of cutting and observing wood.

At first you may lack the physical strength needed to make clean cuts of wood, but this will come with practice as you exercise those muscles. Physical strength is far less important than good technique, but your strength will increase with practice. If either of your hands are feeling weak or beginning to fatigue, stop practicing and allow your strength to return before you continue; shaking your hands to loosen them can be helpful. Controlling the progress of the blade through the wood depends on technique, but fatigue can cause sloppy technique and result in injury. You must not cut if your hands are tired.

You are almost ready to try to cut a specimen; read the section on inspecting the cut first

4.7 Inspecting the cut

Now you have made a cut. Specifically, you have exposed one of the planes of section of the wood, the transverse surface. Inspect it with your hand lens (Fig. 4.8). Pay special attention to the plane you produced and its orientation with respect to the cells; the cells of the axial system should be nearly perpendicular to your cut. If they are not, you must make a new cut, taking special care to orient the edge of the blade at the angle that will produce a true transverse plane. For a tangential plane of section, your cut surface must be perpendicular to the rays as seen on the transverse surface. It must follow the cells of the axial system and it must cut along rather than across the grain.

Now you may, applying the techniques detailed here and with safety foremost in your mind, cut a transverse surface on your practice specimen

After the transverse surface is prepared, note the orientation of the rays and determine if that corner offers a tangential surface. If it does not, re-orient the specimen and prepare a transverse surface on another corner that will allow a tangential surface. Again, focus on safety then prepare the tangential surface.

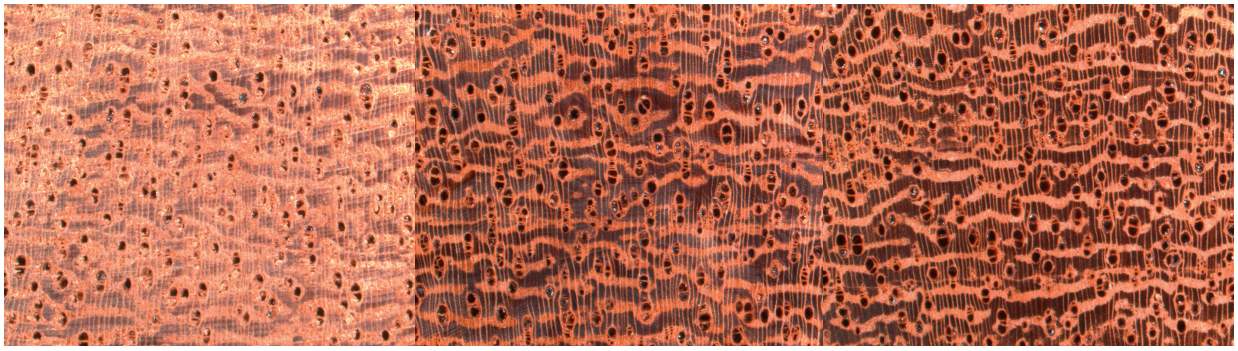


Figure 4.8—Cuts of different quality. The left image shows the specimen cut with a sharp table saw. The middle image shows the specimen cut cleanly with a utility knife. The right image shows the specimen prepared in a laboratory, resulting in a research-quality image.

4.8 Cutting with a razor blade

For soft or low-density woods, a utility knife is the wrong tool for the job and you will need to use a razor blade. The basic principles of cutting and the safety rules are the same for this tool as for a utility knife. You will hold the specimen the same way as well. The only differences are in how to hold the razor blade and the direction of the cutting motion. Razor blades are not strong implements, and when using them, you do not need the force used with a utility knife. Simply pinch the razor blade firmly between your thumb and forefinger, and push (don't pull) the blade from the corner of the specimen across the wood to produce a clean surface. Focus on safety, and allow the blade (rather than brute force) to cut the specimen.

5 | Basic characters used in the identification of wood with a hand lens

The characters presented in this chapter represent the minimal set of terms and concepts necessary to build skill and proficiency in wood identification with a hand lens. This list is not exhaustive, nor does it completely agree with the characters used by other authors, in other references, or in traditional microscopic wood anatomy. The ways in which these characters and definitions deviate from other authors are not important for our purposes, but it is important to note that if you also use other wood identification references, you must compare those authors' definitions of characters to those you learn here. The approach of this manual was chosen based on experience teaching hand lens wood identification at various workshops in Central America, Africa, Asia, and the United States. The intent here is to streamline the learning process and have you working with real wood specimens as quickly as possible. As you use this manual in the field, you will without doubt come across characters from species not covered here. Make note of what you see and compare it with the characters outlined below. If, after careful study and observation, you are certain you have found something not described here, that is excellent! This means you have learned not only the meaning of the characters here but have also gained wisdom sufficient to understand that you are seeing something new.

5.1 Anatomical characters in wood identification

The identification portions of this manual focus on the use of anatomical characteristics to identify unknown wood specimens. With the basic biology of wood familiar to you from the section on wood biology, we will now revisit the cells and structures and define them as characters for identification. In each case, we will be thinking of the structures as either being present or absent in a specimen. This process requires constant observation and questioning: is the character present or absent, or is it impossible to tell? The difference between understanding wood anatomy as a biological field and interpreting that anatomy as characters for identification is a subtle but important one. In Chapter 2 we discussed anatomy in order to understand where the structures in wood come from and what they do in a tree. Now we will define them as observable characters and, as with understanding the pattern of characteristics that define a chair, we will build an understanding of anatomy based on fairly rigid definitions for identification.

Not all images throughout the manual are perfect; some show marks left by the knives that cut them or the sander that smoothed them for photography. Rather than try to explain away the difference between perfect images and surfaces you can produce in the real world, more realistic photos of wood are shown in this manual. In many of the images presented, the notation "M" describes the artifacts of preparation in addition to the anatomical features. As you become proficient in the preparation and observation of wood specimens, you will train your mind to ignore artifacts such as knife marks, but in the initial phases of learning these skills, knife marks can appear to the untrained eye as actual anatomical structures.

The first question to ask yourself when confronting an unknown wood specimen is whether it is a softwood or hardwood. Softwoods are defined anatomically by the absence of vessels (pores) and hardwoods by the presence of pores (Fig. 5.1).

5.1.1 Softwoods

For the softwoods treated in this manual, only two anatomical features can be observed with a hand lens—the presence or absence of resin canals and the characteristics of the transition within the growth rings. Both of these features are seen on the transverse surface, so there is no need to produce a tangential surface on a softwood specimen.

Resin canals

Resin canals are the structures that produce pitch or resin and are found in the wood of *Pinus, Picea, Larix,* and *Pseudotsuga*. When you are first learning wood identification, resin canals can look much like vessels

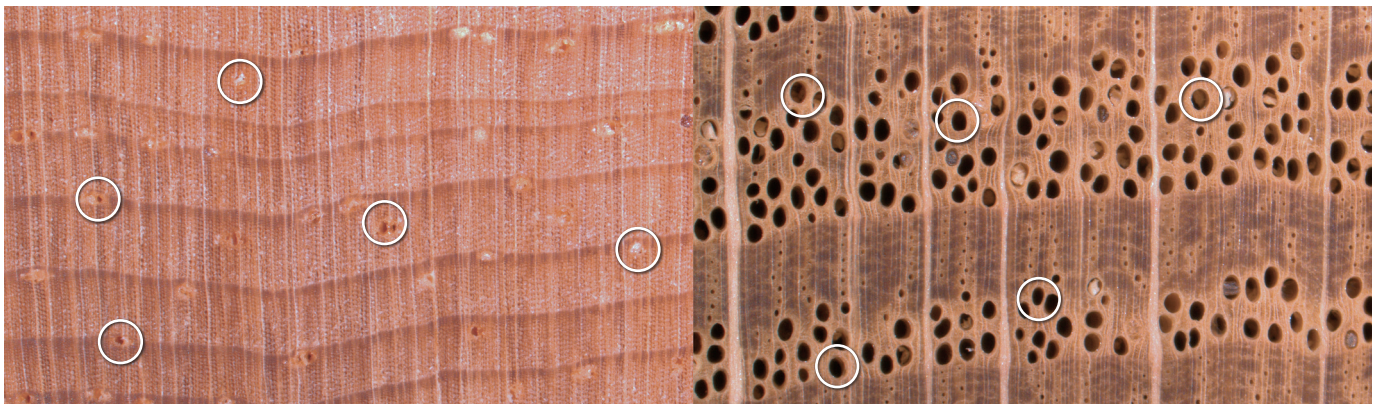


Figure 5.1—Distinguishing softwoods from hardwoods based on the absence or presence of vessels. In the softwood on the left, there are no vessels but several resin canals are circled. In the hardwood on the right, several vessels are circled. Note that the general appearance, number, and distribution of vessels and resin canals are quite different. With practice, you will automatically recognize the characteristics that distinguish vessels from resin canals.

in hardwoods (Fig. 5.1), but there are two easy ways to differentiate them. First, resin canals, if present at all, are usually found in the latewood or in the area between the earlywood and the latewood. Vessels in hardwoods will be found in all portions of the growth ring. Second, even in softwoods with many resin canals, there are still far fewer resin canals in a hand lens view than there are vessels in most hardwoods. With some practice, especially comparing a softwood with resin canals and a hardwood side by side, these specific differences will not be important; you will recognize the pattern of a softwood—with or without resin canals—and you will not confuse resin canals with vessels.

Growth ring transitions

In the growth rings of softwoods, the transition from earlywood to latewood can be abrupt, gradual, or absent (Fig. 5.2a–c). In woods with abrupt transition, there is a clearly visible zone where the tracheid cell wall thickness changes from thin-walled earlywood cells to thick-walled latewood cells (Fig. 5.2a). A gradual transition from earlywood to latewood is one in which the tracheid cell wall thickness becomes slightly greater toward the latewood but with no clear line where the earlywood ends and the latewood begins (Fig. 5.2b). No transition between earlywood and latewood is comparatively rare in softwoods, but it is generally seen in tropical species that lack obvious growth rings (Fig. 5.2c).

5.1.2 Hardwoods

As mentioned earlier, the anatomical variability of hardwoods is many times greater than that of softwoods, and much of this variability can be seen with a hand lens.

Growth rings

There are three classifications of growth rings in hardwoods, depending on transitions in the relative size, pattern, distribution, or abundance of vessels. The three classifications are ring-porous, semi-ring-porous, and diffuse porous (Fig. 5.2d–f).

In **ring-porous woods**, the earlywood vessels are distinctly larger than the latewood vessels (usually from 3 to 10 times the diameter) and also commonly more closely packed together (Fig. 5.2d). The transition between large earlywood vessels and much smaller latewood vessels is distinct. Clearly ring-porous woods are uncommon at the tropical latitudes, except in species at high elevations.

Semi-ring-porous woods are like ring-porous woods in that the earlywood vessels are large and the latewood vessels are half the diameter or smaller, but unlike ring-porous woods, there is a gradual rather than distinct decrease in vessel diameter from the earlywood through the latewood (Fig. 5.2e). This results in a clear distinction between the latewood of one growth ring and the earlywood of the next but no clear distinction between the earlywood and latewood within the same growth ring. Semi-ring-porous woods are more common in tropical latitudes than are ring-porous woods, but they are still comparatively rare.

Diffuse-porous woods, the most common type of hardwood, do not show a large difference in diameter between earlywood and latewood vessels. From the beginning of a growth ring to the end, the vessels are more or less evenly distributed and are of similar size, though in many diffuse-porous woods, there will be a slight decrease in vessel diameter in the latewood (Fig. 5.2f). This small difference in diameter should not be confused with the semi-ring-porous pattern, in which the difference is substantial.

Vessel arrangement

Vessel arrangement is a term used to describe the pattern, if any, of vessels within a growth ring. This is different from the concept of growth ring classification. Most woods have a random distribution of vessels in the wood, but this pattern is not generally considered worthy of a special name as a character because it is the assumed default condition. The concept of vessel arrangement involves two distinct aspects: the number of vessels in contact with each other and the distribution of vessels throughout the growth ring.

When vessels occur one at a time and are not in contact with other vessels, they are called **solitary vessels** (Fig. 5.3a). Most woods have at least a few solitary vessels, but comparatively few woods have exclusively solitary vessels; when this character is present, it is a strong character. When two or more vessels are touching each other and extend in the radial direction (parallel to the rays), they form a **vessel multiple**. Vessel multiples are commonly formed from two to four vessels (Fig. 5.3b); multiples with more than four vessels are less common. When several vessels are in contact radially and tangentially, they form **vessel clusters**. Vessel clusters are much less common than vessel multiples, and thus the presence of this character is a useful one for identification.

Vessels, whether solitary, in multiples, or in clusters, can also have patterns of distribution within the growth ring that receive special names. One pattern is **radially aligned vessels** and occurs when vessels are organized into radial lines or files, often lined up between rays. This pattern can occur in woods with solitary, multiple, or clustered vessels, though it is more common in the former two than the latter. A related pattern is **vessels arranged in echelon** (Fig. 5.3c); this is like radial arrangement, but instead of running parallel to the rays, the vessels form a pattern at a diagonal to the rays. The last pattern is called **dendritic vessel arrangemen**t (Fig. 5.3d), and is characterized by v-shaped, flame-shaped, or tree-like groups of vessels that are narrower on the pith side of the growth ring (toward the earlywood) and widen out toward the bark side (toward and into the latewood). It is important to note that several different vessel arrangements can be present in one wood at the same time. Some hardwoods have axial gum canals that appear similar to small resinous vessels. In this manual, we chose to describe these structures as small vessels.

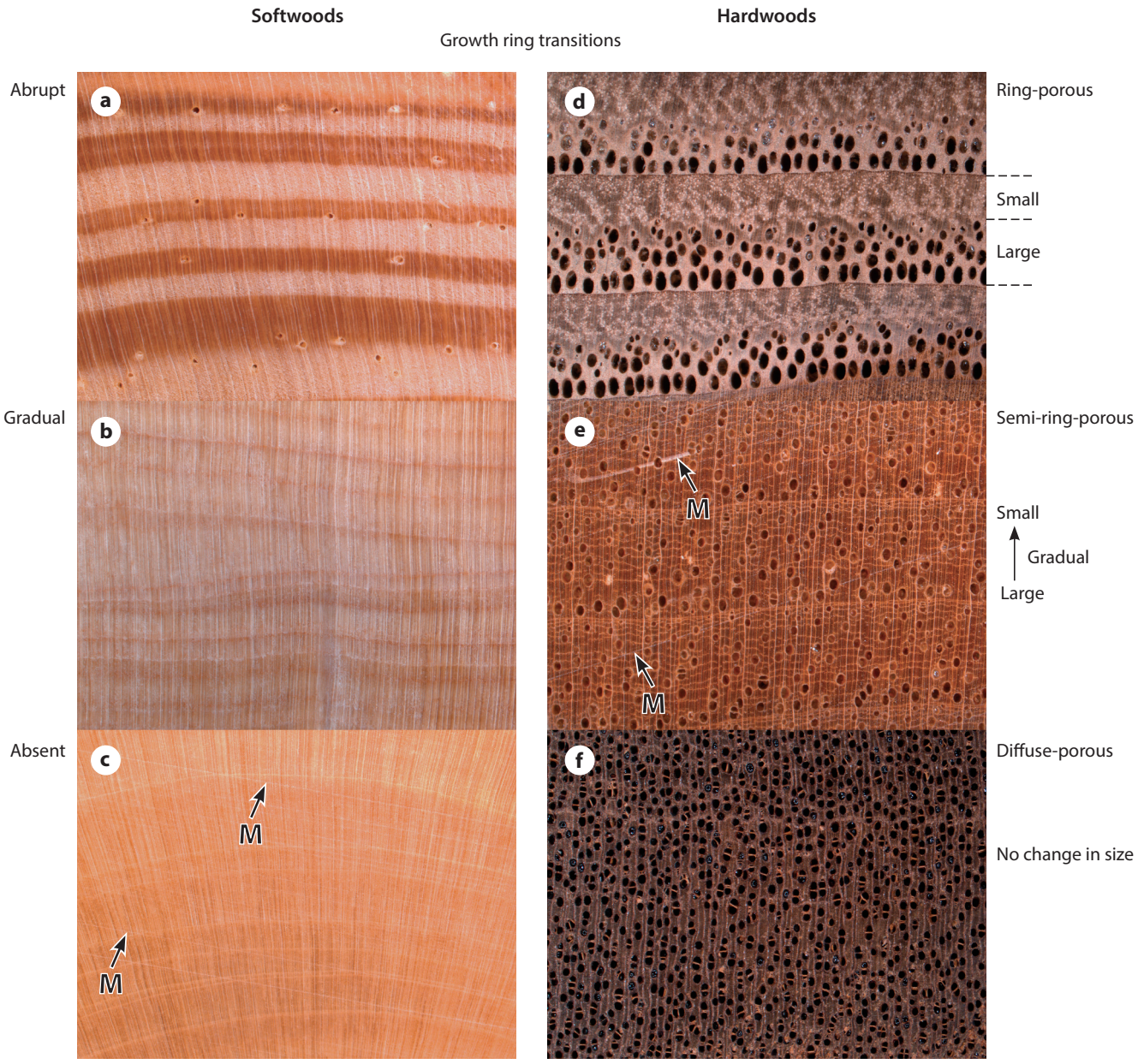


Figure 5.2—Growth ring classifications in softwoods (a–c) and hardwoods (d–f). (a) Abrupt transition within a growth ring from the earlywood to latewood is the most common transition type in the softwoods in this manual. Note how the earlywood appears lighter in color than the latewood, and how the change from earlywood to latewood happens at a distinct place in the growth ring. (b) Gradual transition from earlywood to latewood results in a subtler pattern. (c) No transition within a growth ring is not seen in any of the softwoods in this manual. (d) Ring-porous hardwoods show an abrupt change in vessel diameter at the boundary between the earlywood and the latewood. (e) Semi-ring-porous hardwoods show a gradual reduction of vessel diameter from earlywood to latewood. (f) Diffuse-porous hardwoods, the most common type of growth ring transition in the woods in this manual, show no clear change in vessel size or distribution from the earlywood to the latewood and sometimes lack obvious growth rings altogether.

Rays

As mentioned earlier, rays in hardwoods can be narrow, similar to those of softwoods, or quite wide (Fig. 5.4). They can also be numerous, or a species can have few rays. These characters are best observed from the transverse surface, can be critical in hardwood identification, and are a major part of the wood anatomical pattern. The concepts of narrow, wide, few, and numerous are easily understood by examining photos or transverse surfaces of a variety of hardwoods.

In Chapter 2, the tangential plane of section was described, and in Chapter 4, the method needed to produce it was discussed. It is here that we will apply that knowledge to determine if a wood has nonstoried or storied rays. When looking at a tangential surface, rays will appear as small vertical lines, usually darker than the background. Larger rays are easier to see than small rays, but even tiny rays can be seen with a hand lens if the tangential surface is cut cleanly, the hand lens is used correctly, and the light is falling on the tangential surface at a favorable angle. If a wood has

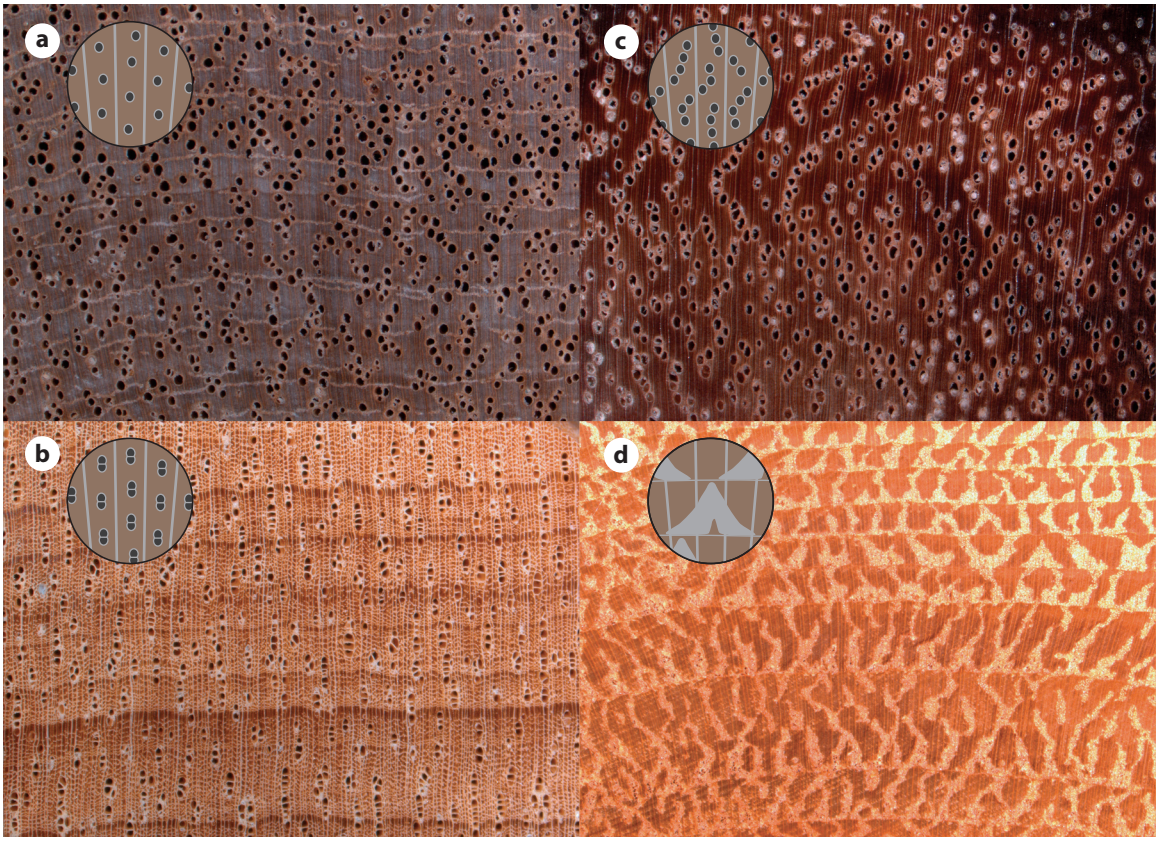


Figure 5.3—Patterns in vessel arrangement. (a) Solitary vessels are those that are not in contact with other vessels. They usually appear distinctly rounded. (b) Vessel multiples are groups of two or more vessels with cell walls in contact. The individual vessels in a vessel multiple often appear slightly flattened where the two vessels touch. (c) Vessels in echelon arrangement can be either solitary vessels, vessel multiples, or a combination of both. The pattern of echelon vessel arrangement must be observed over a wider area, because it is a pattern formed by many vessels and how they are arranged relative to the direction of the rays. (d) Dendritic vessel arrangement is rare or absent in the woods found in this manual, and it is usually found in woods with extremely small-diameter vessels. Most of the vessels in this image are too small to be seen individually with a hand lens.

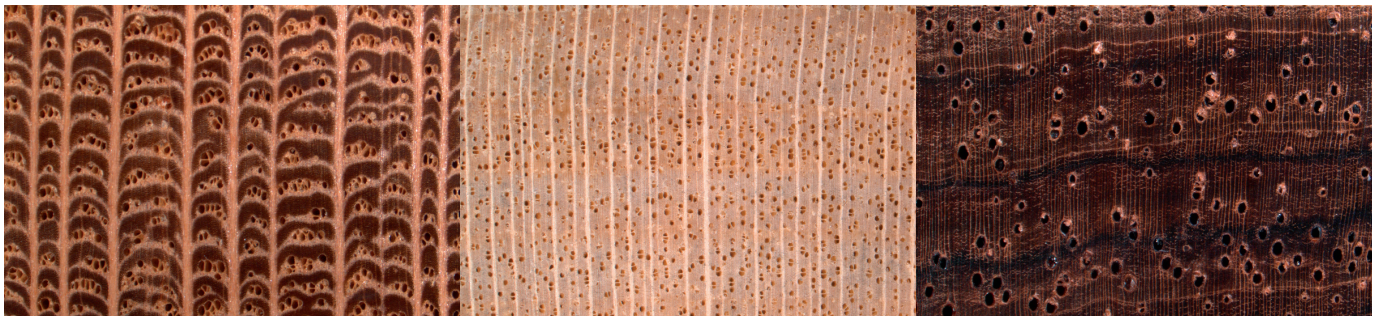


Figure 5.4—Differences in ray width and ray number. The image on the left shows comparatively few, wide rays; however, careful observation will show that there are narrow rays between the wide rays. Observing only the wide rays, this wood has few rays. The middle image shows a wood with an average number and size of rays. The image on the right shows a wood with numerous, narrow rays.

nonstoried rays, the rays will be randomly distributed across the tangential surface; there will be no obvious pattern (Fig. 5.5a). Most woods have nonstoried rays; this is the most common condition in woods worldwide. If a wood has **storied rays**, the rays will be lined up horizontally, much like the windows on the same story in a skyscraper, though in wood, the rays will not be perfectly aligned horizontally but will form somewhat wavy or undulating lines (Fig. 5.5b–d). We further divide woods with storied rays into three broad groups: woods with coarse storying (Fig. 5.5b), woods with medium storying (Fig. 5.5c), and woods with fine storying (Fig. 5.5d). The groups are defined on the basis of the size of the rays and the numbers of stories per millimeter along the grain. Most of the woods with storied rays in this manual have medium storying.

Axial parenchyma patterns

Axial parenchyma patterns in hardwoods are critical characters used in wood identification. Axial parenchyma patterns can be divided into three broad groups, depending on the position and appearance of the parenchyma (Fig. 5.6).

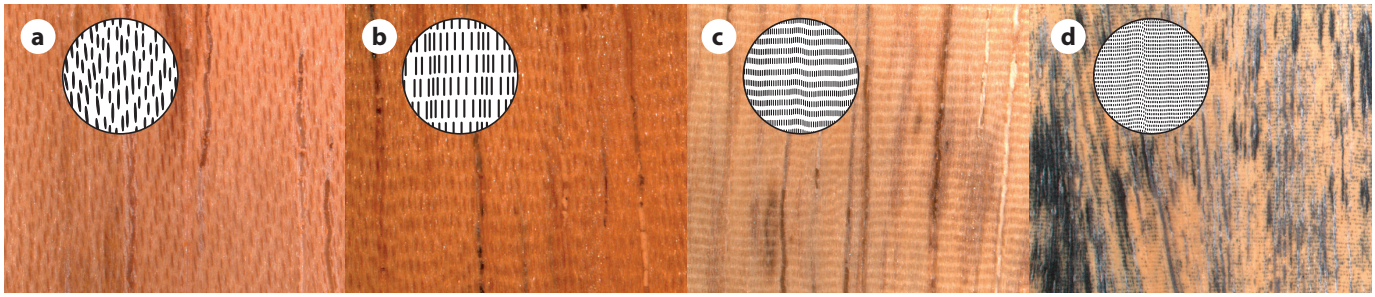


Figure 5.5—Nonstoried and storied rays; this feature can only be observed from the tangential plane of section. (a) An image and illustration of a wood with nonstoried rays. Note that the rays are scattered across the tangential section with no obvious arrangement in horizontal files. The images and illustrations in b–d show woods with storied rays. Woods with storied rays can be grouped into those with coarse storying (b), medium storying (c), or fine storying (d). In many woods, the rays are small enough even when observed with a hand lens that they are difficult to see as separate entities; this is why storied rays produce what is sometimes called 'ripple marks'. This is a term to describe the pattern of wavy horizontal lines formed by the storied rays, which can be easily seen in the image of the wood with medium storying (c). Note also in all images the long vertical lines in the wood; these are vessels cut along their lengths, similar to cutting a pipe lengthwise.

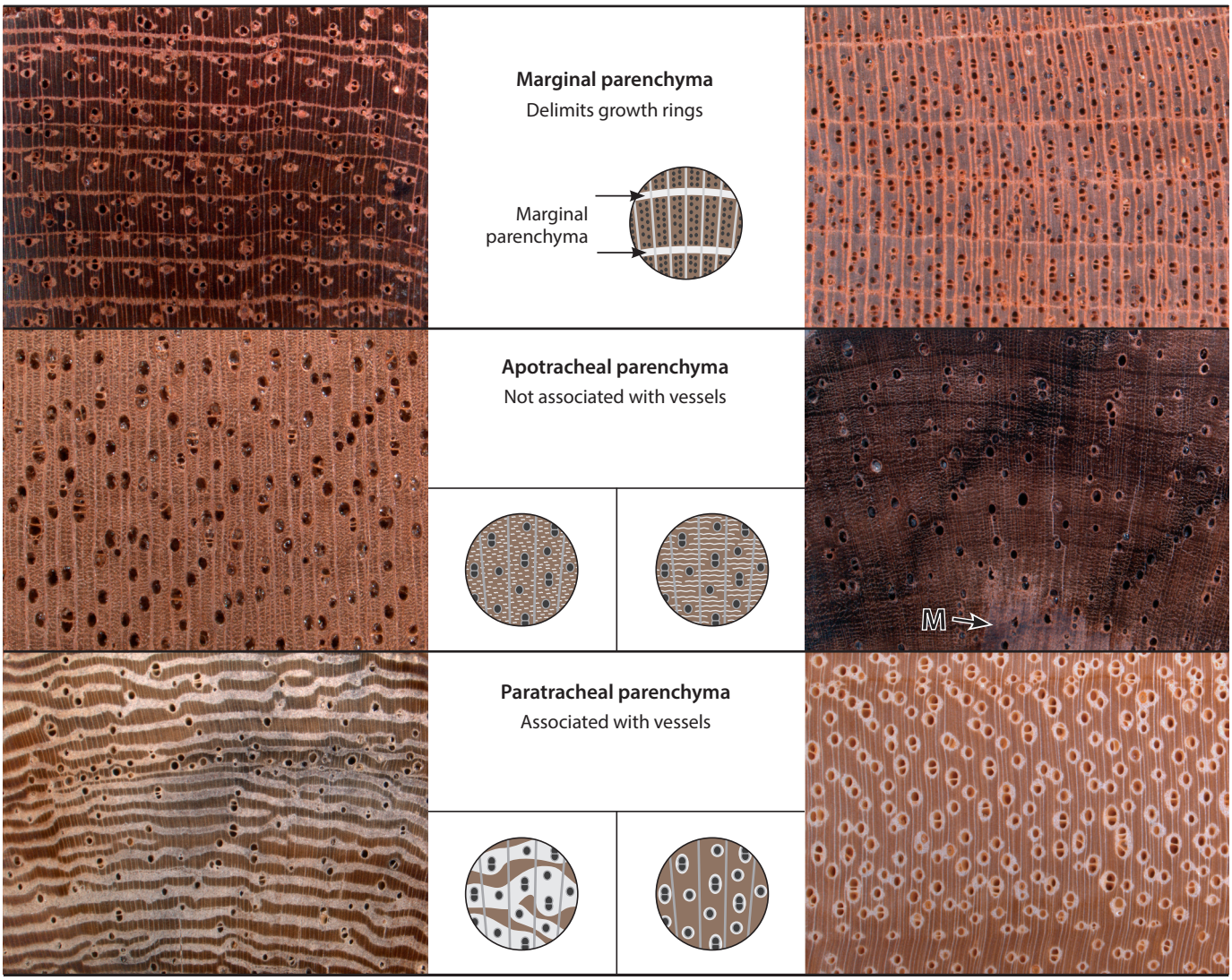


Figure 5.6—There are three types of axial parenchyma in hardwoods: marginal, apotracheal, and paratracheal. Marginal parenchyma occurs at the beginning or end of a growth ring and is shown in the top images and illustrations. Both apotracheal and paratracheal parenchyma occur within the growth ring and differ on the basis of their association with vessels. Apotracheal parenchyma is not associated with vessels and is shown in the middle images and illustrations. Paratracheal parenchyma is closely associated with vessels and is shown in the bottom images and illustrations.

The first type of axial parenchyma is called **marginal parenchyma**. This name is used because marginal parenchyma occurs at the beginning or end of a growth ring and, when present, assists in defining the growth rings of the wood. Because most tropical woods are diffuse-porous, if growth rings are distinctly visible, it is usually because marginal parenchyma is present. Marginal parenchyma appears as a solid line of cells running evenly around the growth ring (Fig. 5.6, top); it generally does not have a wavy or undulating appearance. With some practice, correctly determining the presence of marginal parenchyma is an easy task.

Whereas marginal parenchyma is defined as delimiting the boundary of a growth ring, the other two types of parenchyma are defined on the basis of their association or lack of association with vessels and occur within the body of the growth ring. If the parenchyma is not associated with the vessels, it is called apotracheal parenchyma (Fig. 5.6, middle). If it is associated with vessels, it is called paratracheal parenchyma (Fig. 5.6, bottom). The idea of association with vessels is at first a somewhat complex one, as will be subsequently discussed. Learning the names and patterns of apotracheal and paratracheal parenchyma, and having the words mean the correct things in your mind, is one of the hardest aspects of learning the characters for wood identification. It is helpful to start by using the full name for each type of parenchyma when learning the features and move to the abbreviated names only when you are fully conversant in the terminology for all charcaters.

Apotracheal parenchyma is parenchyma not associated with the vessels and occurs in three basic patterns: diffuse, diffuse-in-aggregate, and banded. These three patterns can be considered part of a continuum (Fig. 5.7b–d); at one end is diffuse apotracheal parenchyma, in the middle is diffuse-in-aggregate apotracheal parenchyma, and at the other end is banded apotracheal parenchyma. **Diffuse apotracheal parenchyma** appears as small dots of generally lighter-colored cells scattered out in the fibers and not touching the vessels (Fig. 5.7b). Diffuse apotracheal parenchyma is often not visible with a hand lens and so will only be used as a character in species that show it clearly. **Diffuse-in-aggregate apotracheal parenchyma** has a similar distribution, but instead of single cells, it is formed of small tangential lines of two to four cells (Fig. 5.7c). This gives it the appearance of short, broken lines of cells running perpendicular to the rays but still not associated with vessels. The aggregates of cells do not usually cross the rays, contributing to its broken appearance. In contrast to diffuse-in-aggregate apotracheal parenchyma, **banded apotracheal parenchyma** is formed of long, wavy lines of cells typically crossing several to many rays (Fig. 5.7d). Depending on the length of the bands, they may appear to be "touching" vessels. You can think of this pattern, when bands contact vessels, as being interrupted by them, rather than associated with them. Individual bands can be from many millimeters in length tangentially to less than half a millimeter in length. Bands can also be radially narrow (a single cell) or wide (many cells).

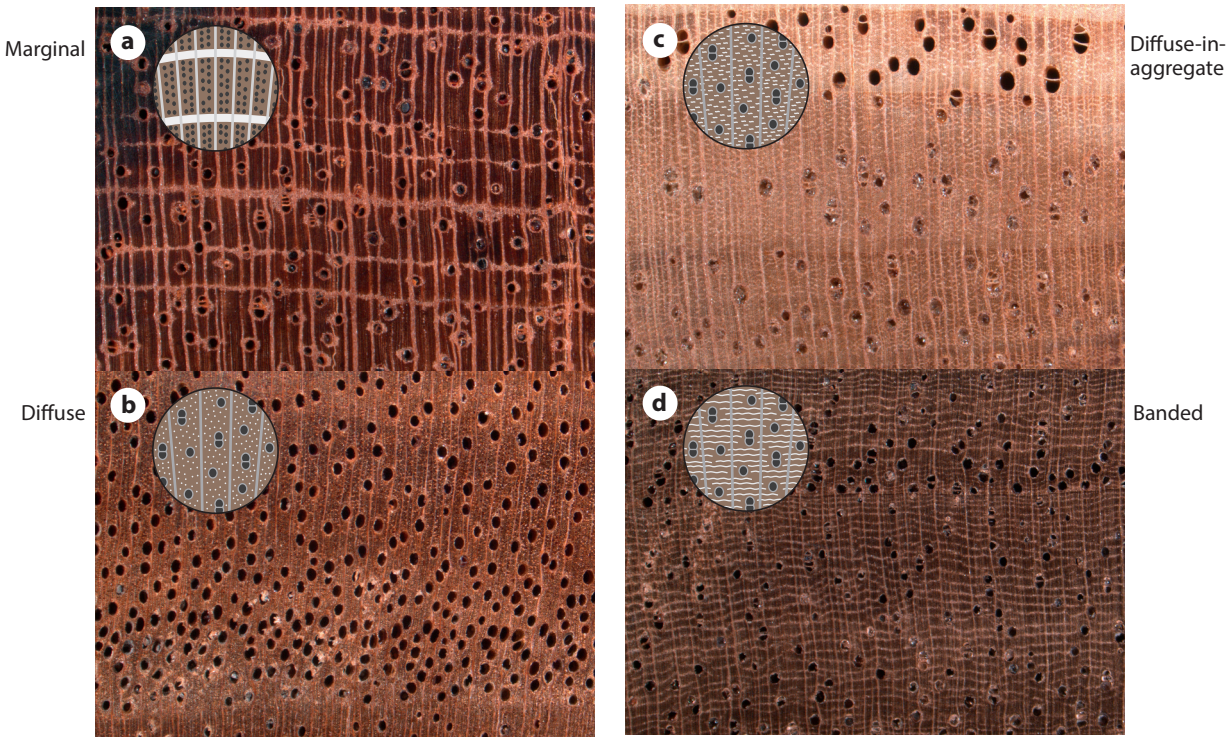


Figure 5.7—Specific axial parenchyma patterns. (a) Marginal parenchyma. Note that the bands of marginal parenchyma are thick. (b) Diffuse apotracheal parenchyma; this, when observable with a hand lens, appears as small dots among the fibers. (c) Diffuse-in-aggregate apotracheal parenchyma appears as short tangential lines among the fibers, and the short lines generally do not cross the rays. (d) Banded apotracheal parenchyma forms long tangential lines among the fibers. The bands typically cross several rays and are often wavy. Compare this pattern with marginal parenchyma in (a).

Paratracheal parenchyma is always clearly associated with the vessels and has a variety of patterns. Much like apotracheal parenchyma, these patterns can be seen as a part of a continuum (Fig. 5.8). At one end of the spectrum is vasicentric paratracheal parenchyma, in the middle is aliform paratracheal parenchyma, and at the other end is confluent paratracheal parenchyma. **Vasicentric paratracheal parenchyma** appears as a round halo or sheath of parenchyma around the vessel, and it can be narrow or wide, referring to distance out from the vessel it extends (Fig. 5.8a). **Aliform paratracheal parenchyma** is like vasicentric paratracheal parenchyma with tangential extensions. That is, there are extensions from the sheath of parenchyma perpendicular to the rays. These extensions can be comparatively thick and short, giving a **lozenge aliform paratracheal parenchyma** pattern (Fig. 5.8b), or long and narrow, giving a **winged aliform paratracheal parenchyma** pattern (Fig. 5.8c). If the wings of aliform paratracheal parenchyma stretch outward and fuse with the wings of adjacent aliform paratracheal parenchyma from another vessel, the pattern formed is called **confluent paratracheal parenchyma** (Fig. 5.8d). Confluent paratracheal parenchyma can connect as few as two vessels or hundreds of vessels. The radial thickness of the parenchyma between vessels can be narrow or wide.

Tyloses and radial canals in hardwoods

Although wood identification has many additional anatomical terms and characters, only two more are necessary to complete our working list of characters used in this manual: tyloses and radial canals. **Tyloses** are outgrowths of parenchyma cells into vessels and appear in the vessels as bubbles or shiny, angled inclusions (Fig. 5.9a,b). Tyloses, in species that have them, are typically found only in the heartwood. For this reason, if you suspect you are examining sapwood, you cannot expect to find tyloses, even if the wood is a species in which they are always found in the heartwood. **Radial resin canals** are structurally similar to the axial resin canals in softwoods but instead are found scattered in the rays. They can be seen reliably only on the tangential surface and appear as dark-colored dots that usually stretch or swell the rays in which they are found (Fig. 5.9c–f). Unlike most of the other anatomical characters in this manual, radial canals have a scattered distribution, and if the key or a species description page asks you to look for them, you must prepare a comparatively large tangential surface and observe it carefully; there may only be one or two radial canals per square centimeter of tangential surface (Fig. 5.9c,e,f). If only a small tangential surface can be prepared, this character must be used only in the positive sense. That is, you may

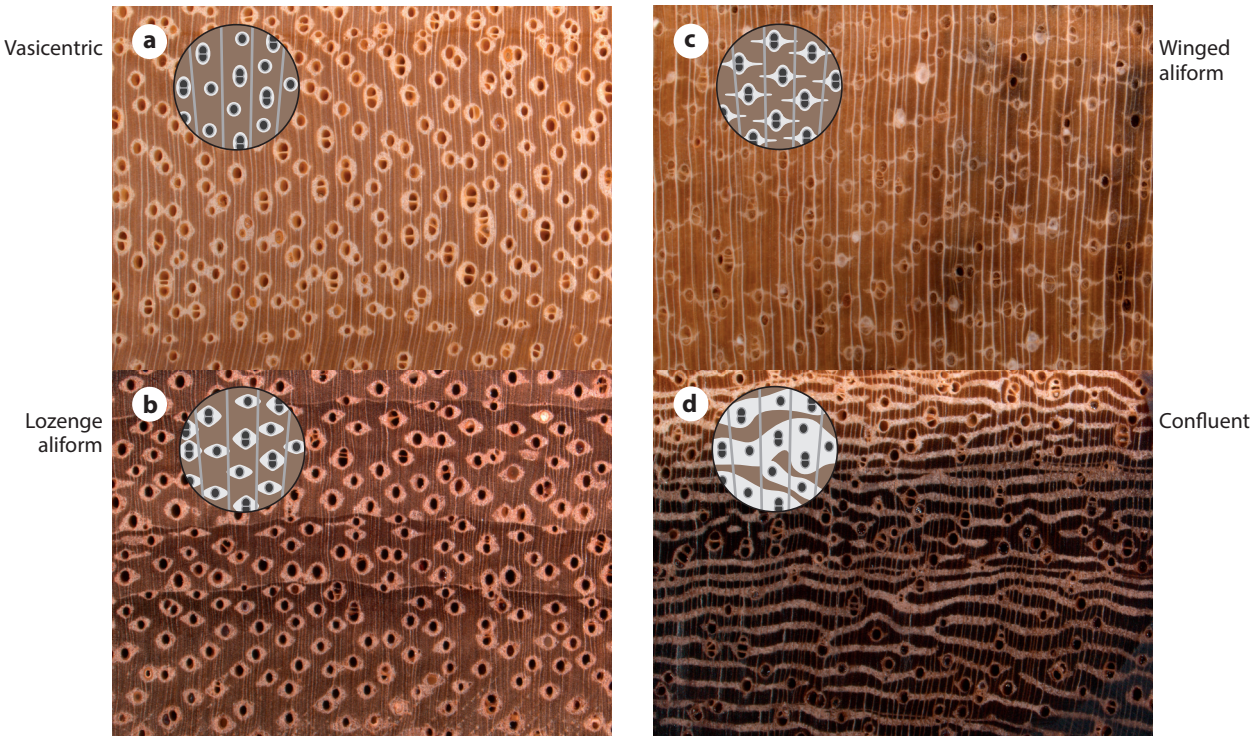


Figure 5.8—Specific axial parenchyma patterns. (a) Vasicentric paratracheal parenchyma appears as an even sheath or halo of parenchyma around the vessels or vessel multiples. (b) Lozenge aliform paratracheal parenchyma appears similar to vasicentric parenchyma, but the parenchyma surrounding the vessels extends tangentially with short, thick projections. (c) Winged aliform paratracheal parenchyma is similar to lozenge aliform parenchyma but with narrow, long wings extending tangentially. (d) Confluent paratracheal parenchyma appears as a series of vessels connected by lozenge aliform or winged aliform parenchyma. The connecting, tangential bands of parenchyma can be narrow or wide and can connect from two to several hundred vessels. Compare this with banded apotracheal parenchyma in Figure 5.6d and note the differences in association of parenchyma with the vessels.

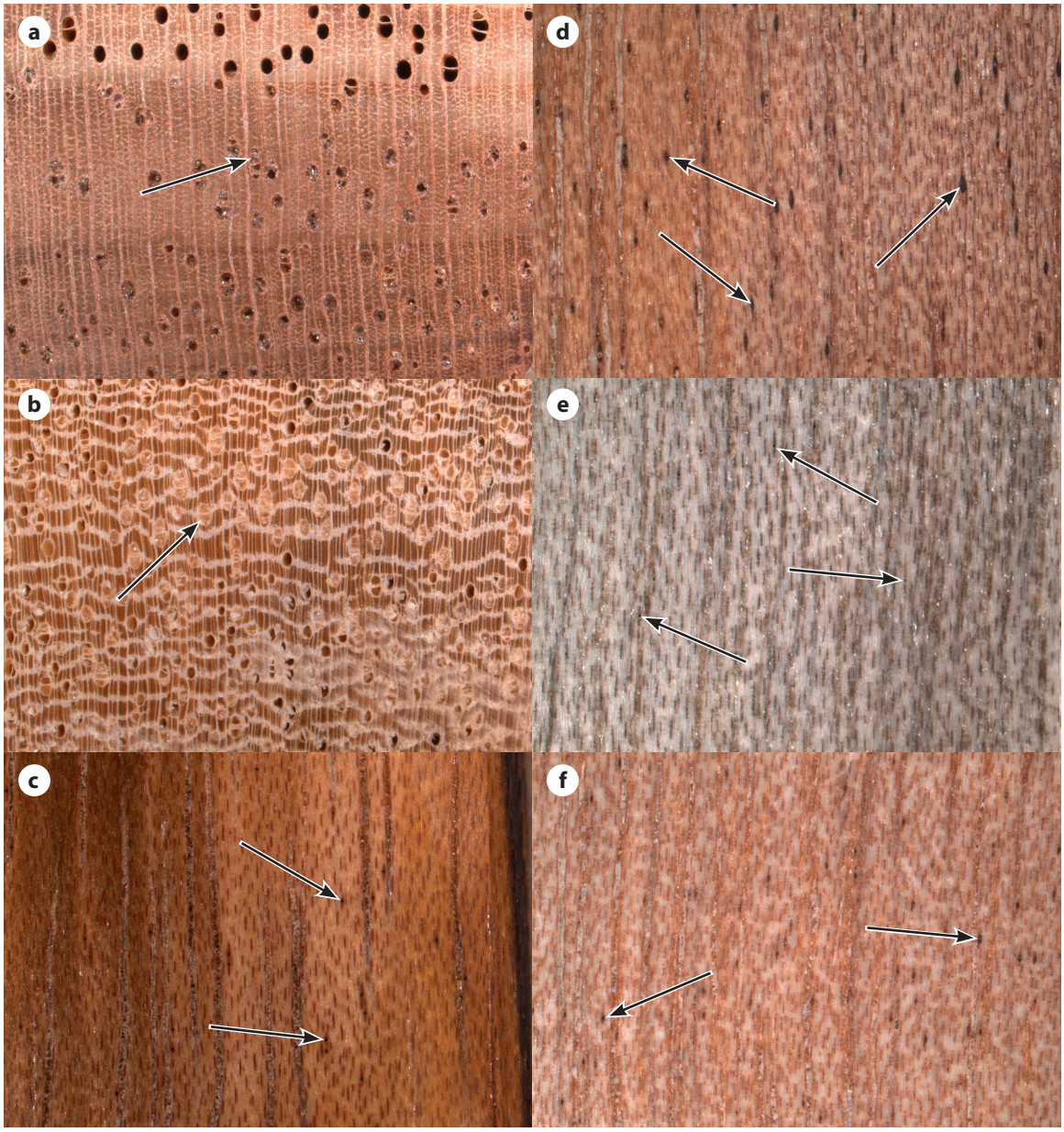


Figure 5.9—Tyloses and radial canals in hardwoods. Tyloses are shiny-appearing outgrowths of parenchyma cells into vessels in the heartwood (a,b). Note that at the top of (a) is a sapwood zone where the vessels are empty. In some species with tyloses, every vessel will be completely filled by tyloses. (b) In other species, vessels can be only partly filled or only some of the vessels have tyloses. Radial canals are special structures embedded in the rays of certain species. They generally appear as black or dark brown dots in expanded rays, as noted by arrows in (c–f), and can be quite difficult to observe with a hand lens, as in (e).

only conclude that the wood has them if you observe them; if you do not observe them in a small area, you cannot properly conclude that the wood doesn't have them.

5.1.3 Growth ring width: plantation or natural stand?

A last anatomical character is the apparent width of the growth rings (Fig. 5.10). Growth ring width is not used to separate different species of wood but can sometimes be used as an indicator of whether the wood you are examining is from a plantation or a natural stand of trees. Generally speaking, plantation-grown species grow much more rapidly than the same species does in nature, resulting in abnormally wide growth rings. Two commonly grown plantation woods are *Tectona grandis* and *Terminalia superba*, though of the two, only *Terminalia* is found in natural stands in Ghana. In both species, plantation-grown material typically has fewer growth rings per centimeter; some plantation trees grow so rapidly that you measure the centimeters per growth ring rather than rings per centimeter. Growth rate is not a definitive way to determine the origin of a timber but may be used as an indicator for further investigation. If you are examining a shipment of *Terminalia* with 4 or 5 growth rings per centimeter and the shipper tells you it is plantation material, it might be appropriate to further investigate their claims; such a growth rate would be more typical of naturally grown material, and such a shipment might have been harvested illegally.

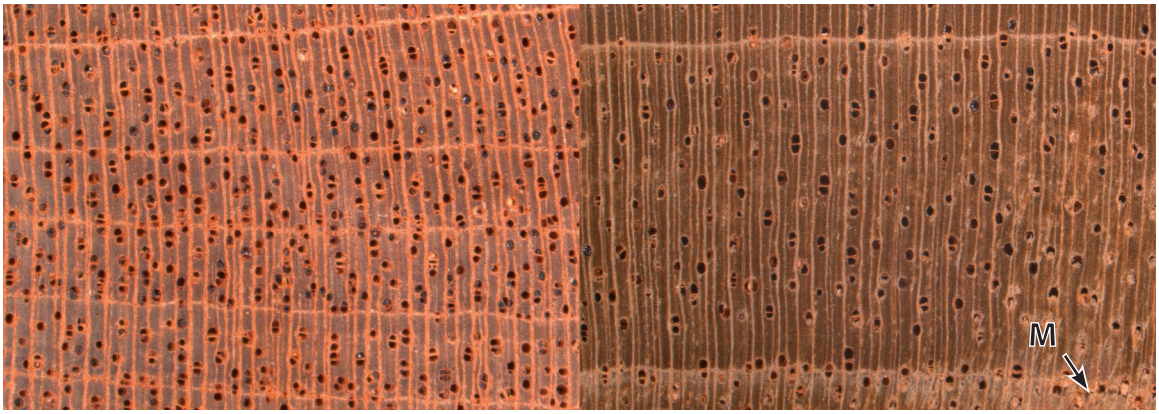


Figure 5.10. Slow-grown (left) and fast-grown (right) woods. There are four complete growth rings (as indicated by the presence of marginal parenchyma) in the image on the left. The image on the right has only one complete growth ring in the same space and thus grew at approximately four times the rate of the wood on the left. A growth rate as fast as this might indicate plantation origin, whereas the growth rate on the left is more typical of a naturally grown tree.

5.2 Nonanatomical characters in wood identification

The characters used in wood identification are primarily anatomical ones, though there are some nonanatomical features that will be referenced in the identification key (Chapter 6) and the species description pages (Chapter 7). These nonanatomical characters include color, luster, odor, density and hardness, regularity of grain, and fluorescence.

5.2.1 Color

Color in wood usually refers to the heartwood color (Fig. 5.11) and is a difficult topic to discuss for several reasons. The heartwood color in a freshly felled log may be quite different from the color of the heartwood once the wood has been dried and processed. Many woods change color with time and exposure to light (e.g., African ebony, *Diospyros*; and Avodire, *Turraeanthus*) even after they are dried and processed. There can also be significant natural biological variability (a wide range of colors) in the color of a given species or timber. Some species have characteristic streaks of color throughout the heartwood that are not always present in small specimens. A further complication is that people see colors differently, and words to describe color often mean different things to different people. For these reasons, the information presented about the color of woods should be interpreted loosely.

5.2.2 Luster

Luster is a property of some woods that, as with color, can be difficult to define and describe. Luster can be defined as a special way in which light reflects from the surface of a block of wood and makes it appear somewhat shiny or silky. It can be nearly impossible to capture photographs of luster in wood, and the appearance of luster also depends on the form of the wood. If the wood is in log form or is rough-cut by a sawmill, even species with luster will not show this character. Smooth, planed, or sanded boards will generally show luster if they are a species that has this character. Some common timbers with luster are *Khaya* (African Mahogany), *Carapa* (Kwakuobese), *Diospyros (*Ebony), and *Pterocarpus* (African Rosewood). Common timbers that lack luster are *Bombax*, *Cordia*, and *Pinus*. The best way to learn to identify luster in wood is to see many specimens of species that have luster and compare them with species that lack it.

5.2.3 Odor

Odor in wood is another nonanatomical character that can be both valuable and difficult to describe. As with color, different people will perceive the odor of the same wood differently, and there can be significant variability in the strength of the odor of wood. Generally speaking, odor is not a strong character and should only be used at the end of an identification when all anatomical characters have

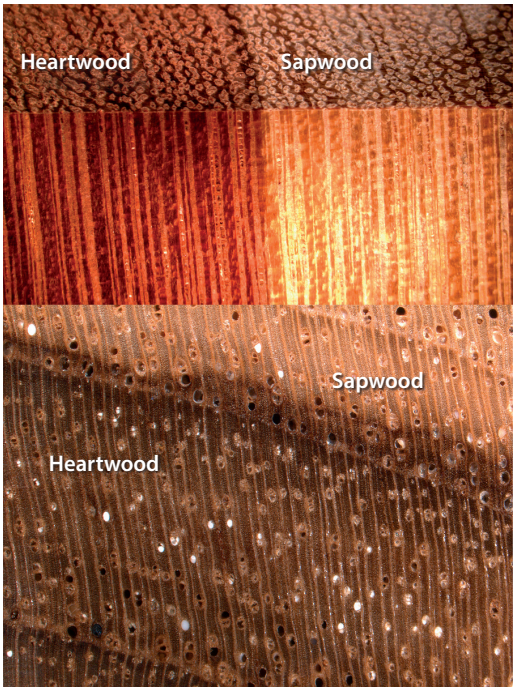


Figure 5.11—Heartwood color is derived from chemicals deposited by the tree as it matures. The top image shows the heartwood–sapwood transition; the sapwood is more yellow in color and the heartwood reddish. The bottom image shows a heartwood–sapwood transition in another wood; the sapwood is whitish and the heartwood a rich brown.

been observed and compared with the images in the species description pages (Chapter 7).

5.2.4 Density and hardness

Density and hardness are related physical properties of wood and have strong influences on the mechanical properties. Density describes the weight or mass of a specimen compared with its volume, and hardness gives information about how easy or difficult it is to cut or dent the wood. The apparent density of a piece of wood is affected by the amount of moisture in the specimen; wood left out in the rain will soak up water and seem denser than wood of the same species that has been properly dried. For this reason, density is best used as a character only when it is clearly quite high or quite low. Most woods are of a medium or average density, and in such species, density is not a useful character. The same thing is true of hardness; if the wood is easy to dent with your fingernail, it is soft. If you cannot dent it with your fingernail, it is hard. Remember that hardness or softness are physical properties of the wood and have nothing to do with whether the wood is a softwood or a hardwood, terms that refer to the botanical origin of the wood and the kinds of cells you will see in them. There are hardwoods in this manual that are low density and soft and several softwoods that are high density and hard. For example, species of *Pinus* in the manual have high-density hard woods, but are softwoods, and *Gmelina* is a hardwood but is soft. For both density and hardness, evaluation of these properties is only meaningful for sound wood. Wood that is decayed or otherwise damaged may seem lighter or softer than the species would normally be.

5.2.5 Regularity of grain

Regularity of grain refers to whether the cells of the axial system of the wood are wavy, interlocked, or straight. Wavy grain occurs when the cells of the axial system run up and down the trunk of the tree with gradual back-and-forth undulations of maybe 1–2 cm. Interlocked grain is formed when the cells of the axial system do not run perfectly straight up and down the tree but rather grow curving up the tree to the right for several years, then curve up the tree to the left for several years, then back to the right. This alternating pattern of curvature up the trunk produces wood that can be quite attractive (especially in species with luster, such as *Khaya*, where interlocked grain is common) but is also difficult to process and sometimes problematic to prepare for hand lens observation because the angle of the grain in one part of specimen is often quite different from the angle in a different part. Straight-grained wood is neither wavy nor interlocked; the cells of the axial system are straight and run up and down the trunk nearly vertically. The regularity of grain is generally not a strong character in wood identification but can affect strength properties of timbers.

5.2.6 Fluorescence

A last nonanatomical character is fluorescence. If you shine a UV lamp (either a small portable light or a larger laboratory model) on freshly sanded or cut surfaces, some woods fluoresce. That is, the slightly purple or invisible UV light is taken up by the specimen, and a different color (usually a yellow-green color) is emitted by the wood. This is most easily seen in dark conditions. Also, some woods have extractives that are fluorescent only when they are dissolved in water. For these woods, a few chips of wood are placed in a small glass vial with 5–10 mL of water and then the UV light is directed into the vial. Water extract fluorescence is usually a bluish color. Most woods lack both surface and water extract fluorescence, so these can be powerful characters for confirming an identification once an initial determination is made based on wood anatomical features, but it can be difficult to assess in the field. Exposure to the weather elements can render a normally fluorescent wood no longer fluorescent, and some decay fungi produce yellow-fluorescent compounds in nonfluorescent woods.

5.2.7 Summary of nonanatomical characters

With practice and experience, all the nonanatomical features discussed here will play a part in your identification of a wood specimen. Because nonanatomical features are generally much weaker than anatomical ones, you will tend to use them either as secondary confirmations (as discussed in the species description pages of Chapter 7) or as an automatic part of pattern recognition, where you do not specifically ask yourself "Does this specimen have luster?" but rather notice automatically whether or not it has this characteristic. That is to say, nonanatomical characters are often some of the first characters that will form a part of the artistic aspect of wood identification.

6 | Identification key

6.1 How to use the key

The key is written to guide you through the identification process in the most efficient and accurate way possible. It presents you with a numbered series of questions. The answers you provide will be based on your interpretations of the anatomical characters in your unknown specimen and will lead you to a new set of questions. In order to understand what the key means by terms like “few”, “average”, “many”, you will need to practice with a few correctly identified specimens—this will train you to use the key as intended. Each time you answer a question and proceed to the next, you are one step closer to making an identification. Eventually, the key will direct you to a species description page in Chapter 7 that will provide more detailed information about the wood. The key will not work in the absence of the species descripion pages; you must go to the suggested species description and compare both the overall pattern and the specific characters of your unknown specimen to the images and text on that page. If your specimen is a good match for the indicated wood, you have successfully identified it. If, however, your unknown specimen is a species not included in the key, the images and information in Chapter 7 will not match, and you must conclude that the specimen is not recognized. This will happen from time to time, because no key includes all woods. Let us reiterate, to make a correct identification, the following key must be used with the species description pages for this manual to function properly. Failing to use the species description pages in Chapter 7 would be like traveling by airplane and failing to claim your luggage from the baggage claim at your destination; you would be assuming it arrived at the airport with you, but you would not know.

6.2 Checklist of features

A checklist like the following one can be helpful when identifying an unknown specimen because it encourages you to go through the process of observing specific features useful in wood identification. It can prevent you from overlooking an important character or failing to check for the presence of all possible features. With practice and experience, such a checklist will be less useful to you for wood patterns you recognize automatically, but it can help with difficult specimens even when you have years of practice identifying wood.

Checklist of characters

Softwoods (vessels absent)				Present or absent?
Resin canals				
Hardwoods (vessels present)				**Present or absent?**
Growth rings	Ring-porous to semi-ring-porous			
	Diffuse-porous			
Vessel arrangement	Solitary			
	Multiples			
	Clusters			
	Radial			
	Echelon			
	Dendritic			
Vessel contents	Powders (white, yellow, etc.)			
	Tyloses			
	Gums or resins			
Vessel size	Small			
	Medium			
	Large			
Vessel abundance	Sparse			
	Few			
	Medium			
	Abundant			
Ray size	Narrow			
	Medium			
	Wide			
Ray abundance	Few			
	Average			
	Numerous			
Rays as observed from the tangential surface	Nonstoried			
	Storied	Coarse		
		Medium		
		Fine		
Axial parenchyma	Marginal			
	Apotracheal	Diffuse		
		Diffuse-in-aggregate		
		Banded	Long bands	
			Short bands	
			Wide bands	
			Narrow bands	
	Paratracheal	Vasicentric	Narrow	
			Wide	
		Aliform	Winged	
			Lozenge	
		Confluent	Connecting few vessels	
			Connecting many vessels	

	Wood characteristics	Further choice/result
1	Rays absent	2
1	Rays present	3
2	Vascular bundles occupying well over 50% of the area on the tranvserse surface, "wood" hard, heavy, and dark brown to black with narrow, lighter streaks	***Borassus aethiopum,*** p. 51
2	Vascular bundles occupying 50% or less of the area on the tranvserse surface, "wood" medium density, light brown in color with darker streaks	***Cocos nucifera,*** p. 59
3	Vessels absent; earlywood–latewood transition abrupt, and latewood with resin canals	***Pinus* spp.,** p. 103
3	Vessels present	4
4	Rays storied (observed on the tangential surface)	5
4	Rays nonstoried (observed on the tangential surface)	20
5	Vessels small, only visible with a hand lens and not visible to the naked eye	6
5	Vessels medium to large, typically visible with the naked eye and easily visible with a hand lens	10
6	Axial parenchyma predominantly apotracheal	7
6	Axial parenchyma predominantly paratracheal	9
7	Axial parenchyma diffuse-in-aggregate	8
7	Axial parenchyma in narrow apotracheal bands	***Dialium aubrevillei,*** p. 67
8	Vessels small, sometimes in radial arrangement; wood high density and dark reddish brown in color	***Nesogordonia papaverifera,*** p. 99
8	Vessels small to medium, sometimes with tyloses; wood medium density and grey-green to grey-brown in color	***Mansonia altissima,*** p. 91
9	Axial parenchyma winged aliform to narrow confluent; wood medium density, yellowish in color	***Holoptelea grandis,*** p. 81
9	Axial parenchyma almost entirely confluent, alternating regularly with thick-walled fibers; apparent growth increments demarcated by very fine marginal parenchyma followed by a band of fibers with few or no vessels; wood hard and high density, yelllowish to brown in color.	***Baphia nitida,*** p. 47
10	Axial parenchyma apotracheal or if paratracheal, not predominantly confluent, if confluent parenchyma is present, it does not connect the majority of the vessels	11
10	Axial parenchyma predominantly confluent with most vessels connected by confluent bands	13
11	Axial parenchyma diffuse-in-aggregate, vessels often with tyloses, rays medium to wide	***Bombax brevicuspe,*** p. 50
11	Axial parenchyma in the body of the growth ring, vasicentic or sometimes confluent connnecting few vessels; marginal parenchyma present	12
12	Marginal parenchyma narrow, axial parenchyma predomoninantly vasicentric, sometimes aliform to short confluent, virtually all vessels with paratracheal parenchyma, narrow gum-filled vessels common; wood yellow-brown to light reddish brown, without pleasant odor	***Daniellia* spp.,** p. 66
12	Marginal parenchyma typically wide, axial parenchyma confluent, but many vessels with no paratracheal parenchyma of any kind, dark gums common in vessels; wood reddish brown and often with a pleasant spicy aroma	***Entandrophragma cylindricum,*** p. 73
13	Wood clearly diffuse-porous, storying medium or coarse	14
13	Wood typically subtly semi-ring-porous, storying fine	***Pterocarpus erinaceus,*** p. 106
14	Vessel arrrangement clearly in echelon, confluent parenchyma paralleling echelon arrangement or connecting few vessels	15
14	Vessel arrangement not clearly in echelon, most vessels connecting tangentially in confluent parenchyma	16

15	Vessels large and abundant, typically easily visible to the naked eye, vessels often with dark gums and light-colored powders	***Erythrophleum suaveolens,*** p. 74
15	Vessels small and abundant, not visible to the naked eye but easily resolved with a hand lens	***Pericopsis elata,*** p. 102
16	Axial parenchyma predominantly confluent in wide bands alternating regularly with thick-walled fibers, easily seen with the naked eye.	17
16	Axial parenchyma vasicentric to aliform to confluent, easily seen with hand lens but not evident to the naked eye.	18
17	Storying regular and medium, rays fairly small on the tangential surface	***Lonchocarpus sericeus,*** p. 86
17	Storying irregular and comparatively coarse, rays fairly tall on the tangential surface	***Amphimas pterocarpoides,*** p. 41
18	Rays always well-storied, medium storying, vessels medium diameter, axial parenchyma aliform to confluent, with narrow marginal parenchyma present	***Distemonanthus benthamianus,*** p. 70
18	Rays irregularly storied	19
19	Axial parenchyma in long, widely to regularly spaced narrow confluent bands appearing as connected thin-winged aliform parenchyma	***Quassia gabonensis,*** p. 108
19	Axial parenchyma vasicentric to wide lozenge aliform but predominantly confluent in wide, closely spaced confluent bands appearing as connected wide lozenge aliform parenchyma, sometimes with faint, narrow marginal parenchyma, heartwood vessels commonly with dark gums	***Parkia* spp.,** p. 101
20	Rays at least in part medium to wide	21
20	Rays very narrow to narrow	36
21	Axial parenchyma essentially absent	22
21	Axial parenchyma clearly present	24
22	Vessels small and abundant, not visible with the naked eye but easily seen with a hand lens; rays medium-wide and numerous, rays wider than vessels	***Scottellia coriacea,*** p. 110
22	Vessels medium size, sometimes visible to the naked eye; rays average to very wide, average abundance	23
23	Rays wide and very wide, average abundance, much wider than the vessels	***Vernonia conferta,*** p. 120
23	Rays average to medium-wide, narrower than the vessels; vessels often with dark gums; wood reddish brown and lustrous	***Khaya* spp.,** p. 83
24	Axial parenchyma almost exclusively marginal	***Carapa procera,*** p. 53, and rare specimens of ***Khaya* spp.,** p. 83
24	Axial parenchyma in the body of the growth ring common, marginal parenchyma present or absent	25
25	Axial parenchyma abundantly apotracheal and paratracheal, marginal parenchyma present; vessels large and often in tangential clusters, commonly with abundant tyloses	***Cordia milleni,*** p. 62
25	Axial parenchyma either predominantly apotracheal or predominantly paratracheal	26
26	Axial parenchyma predominantly apotracheal; parenchyma, especially bands, may touch the vessels, but all vessels are not surrounded by parenchyma even if some vessels are, in whole or in part	27
26	Axial parenchyma predominantly paratracheal and clearly associated with the vessels	34
27	Apotracheal axial parenchyma almost exclusively diffuse-in-aggregate	28
27	Apotracheal axial parenchyma almost exclusively banded	31
28	Apotracheal parenchyma predominantly diffuse, some diffuse-in-aggregate, sometimes faint and narrow paratracheal vasicentric or lozenge aliform; wood medium density and typically reddish brown	***Tarrietia utilis,*** p. 113
28	Apotracheal parencyma predominantly and distinctly diffuse-in-aggregate	29

29	Rays nearly all wide to very wide	***Sterculia tragacantha,*** p. 111
29	Rays medium to wide, wide rays not abundant	30
30	Vessels large to very large and abundant, easily visible to the naked eye, sometimes with tyloses; the widest rays seen on the tangential surface never more than half the magnified diameter seen with a hand lens	***Ceiba pentandra,*** p. 55
30	Vessels large and abundant, easily visible to the naked eye, sometimes with tyloses; the widest rays seen on the tangential surface often more than half the magnified diameter seen with a hand lens	***Bombax buonopozense,*** p. 50
31	Apotracheal bands of parenchyma wide and abundant, regularly alternating with narrow bands of fibers of similar width, possibly appearing as confluent	32
31	Apotracheal bands of parenchyma narrow, either quite narrow and evenly spaced or narrow and widely and irregularly spaced	33
32	Wood low to medium density; whitish to yellowish in color	***Sterculia oblonga,*** p. 111
32	Wood medium density; reddish brown in color	***Sterculia rhinopetala,*** p. 111
33	Apotracheal banded parenchyma widely spaced, wavy, and irregular; vessels quite large and easily visible with the naked eye; wood whitish to greyish and low density	***Cleistopholis patens,*** p. 58
33	Apotracheal banded parenchyma narrow and closely spaced; vessels medium to medium-large and typically visible with the naked eye; wood brownish and medium density	***Duguetia staudtii,*** p. 71
34	Paratracheal winged aliform and confluent parenchyma in narrow widely spaced bands, parenchyma making up less than 20% of the area	***Quassia gabonensis,*** p. 108
34	Paratracheal confluent parenchyma in wide, typically closely spaced bands, parenchyma well over 20% of the area, often closer to 40–50%	35
35	Paratracheal confluent parenchyma wide and often undulating; vessels large and few, easily seen with the naked eye; the height of the tallest rays seen on the tangential surface always less than one-quarter of the view in a 14x hand lens; wood sometimes appearing faintly semi-ring-porous; wood light to medium brown	***Entada abyssinica,*** p. 72
35	Paratracheal confluent parenchyma in wide regular bands; vessels medium to medium-large and numerous, easily seen with the naked eye; the height of the tallest rays seen on the tangential surface often more than one-third of the view in a 14x hand lens; wood whitish to greyish	***Cola gigantea,*** p. 60
36	Axial parenchyma essentially absent	37
36	One or more types of axial parenchyma clearly present	47
37	Vessels very small to medium-small, visible with a hand lens, but not clearly visisible to the naked eye	38
37	Vessels medium-small to large, visible to easily visible to the naked eye	42
38	In addition to numerous small vessels, large, irregularly shaped structures with resinous or gummy contents visible on the transverse surface	***Memecylon lateriflorum,*** p. 93
38	Large, irregularly shaped structures with resinous or gummy contents absent	39
39	Radial canals in rays visible with a hand lens on tangential surface, often appearing as large black dots in the rays	***Lannea welwitschii,*** p. 85
39	Rays when seen with a hand lens on the tangential surface without radial canals	40
40	Vessels small, easily visible with a hand lens, abdundant, but not so many that it would be impossible to count the vessels in one-quarter of the hand lens view	***Margaritaria discoidea,*** p. 92
40	Vessels very small and abundant, visible with a hand lens but far too numerous to count in one-quarter of the hand lens view	41
41	All rays narrow, abundant, regularly spaced	***Hymenocardia acida,*** p. 82
41	Rays of two sizes, extremely narrow and sligthly but distinctly wider; wider rays irregularly spaced but still numerous	***Voacanga africana,*** p. 122

42	Radial canals in rays visible with a hand lens on tangential surface, often appearing as small black dots in the rays	43
42	Rays when seen with a hand lens on the tangential surface without radial canals	44
43	Vessels not easily visible without a lens; radial canals at most one per ray	***Antrocaryon micraster,*** p. 46
43	Vessels easily visible without a lens; radial canals often more than one canal per ray	***Pycnanthus angolensis,*** p. 107
44	Wood low to medium density; whitish to yellowish in color	45
44	Wood medium density; reddish brown to brown in color	46
45	Vessels medium to large, easily visible with the naked eye and with a hand lens, vessels often empty, sometimes with tyloses	***Canarium schweinfurthii,*** p. 52
45	Vessels medium to medium-large, usually visible to the naked eye and easily visible with a hand lens, often with light-colored gums	***Turraeanthus africanus,*** p. 119
46	Vessels medium-small to medium and abundant; rays varying in width from extremely narrow to medium-narrow	***Khaya* spp.,** p. 83
46	Vessels medium-small to medium, often in echelon arrangement and radial multiples of 2–6; all rays extremely narrow	***Blighia sapida,*** p. 49
47	Wood subtly ring-porous to semi-ring-porous	48
47	Wood diffuse-porous	50
48	Earlywood vessels barely visible to the naked eye or not visible, latewood vessels too small to be seen with the naked eye; rays narrow to medium width	***Vitex micrantha,*** p. 121
48	Earlywood vessels easily seen with the naked eye, latewood vessels often also visible with the naked eye; rays narow	49
49	Earlywood vessels loosely spaced and typically only in one row, vessels throughout the growth ring often with dark-colored gums; wood without oily texture; heartwood typically with a pleasant spicy scent	***Cedrela odorata,*** p. 54
49	Earlywood vessels typically well-organized, often in more than one row, often with prominent tyloses in the heartwood; wood with oily texture; without spicy scent	***Tectona grandis,*** p. 114
50	Parenchyma in the body of the growth ring absent, marginal parenchyma clearly present	Some rare specimens of ***Khaya,*** p. 83, or ***Entandrophragma*****,** p. 73
50	Parenchyma in the body of the growth ring present, with or without marginal parenchyna	51
51	Parenchyma in the body of the growth ring predominantly apotracheal	52
51	Parenchyma in the body of the growth ring predominantly paratracheal	69
52	Parenchyma in the body of the growth ring predominantly apotracheal diffuse and/or diffuse-in-aggregate	53
52	Parenchyma in the body of the growth ring predominantly apotracheal banded	62
53	Vessels very small to medium-small and abundant, too small to be seen with the naked eye but visible with a hand lens	54
53	Vessels medium-small to large, visible with the naked eye	57
54	Parenchyma almost exclusively apotracheal diffuse	***Aidia genipiflora,*** p. 39, or ***Corynanthe pachyceras,*** p. 63
54	Parenchyma predominantly diffuse-in-aggregate	55
55	Vessels in radial multiples of 2–6 or more common	56
55	Vessels solitary and in radial multiples of 2–3 common	***Strombosia glaucescens,*** p. 112
56	Vessels not abundant, vessel multiples with tapered outline; wood whitish to greyish, low density and soft	***Holarrhena floribunda,*** p. 80
56	Vessels numerous, solitary vessels and vessel multiples with rounded outline; wood shades of brown, medium-high density and hard	***Mitragyna stipulosa,*** p. 95

57	Vessels exclusively solitary; wood other than whitish or greyish in color	58
57	Vessels commonly at least in part in radial multiples; wood whitish or reddish brown	59
58	Large, resinous radial canals easily seen with the hand lens, often barely visible to the naked eye; resinous spots often visible to the naked eye on longtudinal surfaces	***Mammea africana,*** p. 89
58	Radial canals absent; wood with a reddish-orange cast	***Nauclea diderrichii,*** p. 98
59	On the tangential surface, vessels, fibers, and parenchyma cells are storied but rays are not, appearing as faint wavy white lines; vessels quite large, marginal parenchyma well-developed; wood whitish to light yellow, light and soft	***Triplochiton scleroxylon,*** p. 118
59	All storying absent on the tangential surface	60
60	Rays two sized, narrow and medium-narrow to medium; axial parenchyma mostly diffuse-in-aggregate, but narrow vasicentric and lozenge also present; heartwood reddish brown	***Tarrietia utilis,*** p. 113
60	Rays all narrow; paratracheal parenchyma absent; heartwood whitish to greyish	61
61	Vessels extremely large, easily seen at a distance with the naked eye	***Ricinodendron heudelotii,*** p. 109, or ***Discoglypremna caloneura,*** p. 69
61	Vessels medium-large to large, visible to the naked eye	***Funtumia elastica,*** p. 75, or ***Tetrorchidium didymostemon,*** p. 116
62	Vessels large to extremely large, easily visible to the naked eye at a distance	63
62	Vessels small to medium diameter, not readily visible to the naked eye but easily seen with a hand lens	66
63	Vessels exclusively solitary and extremely large	***Parinari excelsa,*** p. 100
63	Vessels solitary and in multiples	64
64	Axial parenchyma in prominent, abundant, wide bands alternating with fibers; vessels large; wood dark in color and high density	***Lophira alata,*** p. 87
64	Axial parenchyma in thin, narrow, widely or closely spaced bands; wood whitish to greyish in color and low density	65
65	Apotracheal banded parenchyma narrow but closely spaced; vessel multiples of 2–5 common, often also in clusters, vessels commonly with tyloses; marginal parenchyma as fine brown lines commonly well-developed	***Hevea brasiliensis,*** p. 79
65	Apotracheal banded parenchyma narrow and widely spaced, radial vessel multiples in excess of 8 common; marginal parenchyma sometimes present, typically as faint white lines	***Alstonia boonei,*** p. 42
66	Apotracheal banded parenchyma in extremely fine lines narrower than the rays; vessels solitary and in multiples of 2–3	***Diospyros* spp.,** p. 68
66	Apotracheal banded parenchyma in wider bands often as wide as or wider than the rays; vessels mostly in radial mutiples of 4 or more	67
67	Vessels and vessel multiples also with prominent echelon arrangement, medium diameter	***Tieghemella heckelii,*** p. 117
67	Vessels and vessel multiples in radial arrangement, small to medium-small	68
68	Vessels small; wood brown to dark brown, extremely hard and heavy and difficult to cut with a utility knife	***Manilkara obovata,*** p. 90
68	Vessels small to medium-small; wood light brown to brown, moderately hard and heavy, can be cut with a utility knife	***Pouteria altissima,*** p. 105, or ***Chrysophyllum* spp.,** p. 57
69	Paratracheal parenchyma predominantly confluent with or without other types of parenchyma in a minority fraction	70
69	Paratracheal parenchyma predominantly vasicentric or aliform, with or without other types in a minority fraction	78

70	Confluent paratracheal parenchyma in narrow bands, generally not visible or barely visible to the naked eye but easily seen with a hand lens	71
70	Confluent paratracheal parenchyma in wide bands easily seen with the naked eye	72
71	Confluent paratracheal parenchyma in narrow, regular bands; vessels small and not abundant; apparent growth rings delimited by areas with few or no vessels or parenchyma; wood medium-high density and dark brown	***Cynometra ananta,*** p. 65
71	Confluent paratracheal parenchyma in looser, undulating bands; vessels small and abundant; wood medium density and light reddish brown	***Guarea cedrata,*** p. 78
72	Nearly all heartwood vessels almost completely occluded by abundant and easily visible tyloses	73
72	Some vessels in heartwood with tyloses but most without, or tyloses absent	75
73	Confluent paratracheal bands of parenchyma of similar width to bands of fibers and alternating regularly, extending tangentially for mm or cm	***Morus mesozygia,*** p. 97
73	Confluent paratracheal bands of parenchyma wavy and irregular, narrower than bands of fibers	74
74	Vessels medium to medium-large, average abundance; bands of parenchyma wavy and relativelty short connecting only 2–5 vessels; wood medium density, readily cut with a utility knife	***Milicia* spp.,** p. 94
74	Vessels medium and abundant; bands of parenchyma narrow, frequent, and connecting many vessels; wood high density and hard, difficult to cut with a utility knife	***Klainedoxa gabonensis,*** p. 84
75	Vessels small to medium-small and abundant, too numerous to count with a hand lens; confluent bands wavy and narrow, and aliform parenchyma common; wood whitish to yellowish	***Celtis* spp.,** p. 56
75	Vessels medium to medium-large, not numerous, inconvenient but possible to count with a hand lens; confluent bands prominent and distinct, easily seen with the naked eye	76
76	Confluent paratracheal parenchyma bands distinctly narrower than the bands of fibers; rays extremely narrow and abudnant; wood whitish to greyish and medium to low density	***Anthocleista nobilis,*** p. 44
76	Confluent paratracheal parenchyma bands of similar width to the bands of fibers; rays narrow and abundant or medium-narrow and of average abundance; wood yellowish to reddish orange, medium to high density	77
77	Confluent paratracheal parenchyma abundant and in closely spaced bands; on the tangential surface no storying	***Morinda lucida,*** p. 96
77	Confluent paratracheal parenchyma in thick bands; on the tangential surface, fibers and parenchyma are storied, giving rise to faint yellowish wavy lines	***Amphimas pterocarpoides,*** p. 41
78	Heartwood vessels typically occluded with well-developed, distinct, and abudand tyloses	***Gmelina arborea,*** p. 77
78	Heartwood vessels without tyloses, or if tyloses present, not occluding vast majority of heartwood vessesl and/or not distinct or well-developed	79
79	Apparently marginal parenchyma distinctly present and well-developed, in moderately thick lines	80
79	Marginal parenchyma in fine lines, faint, irregular, or absent	84
80	Wide bands of marginal parenchyma with numerous small vessels filled with dark resinous material—these are not tangential bands of wound tissue	***Copaifera salikounda,*** p. 61
80	Marginal parenchyma without small, resinous vessels	81
81	Parenchyma in the body of the growth ring not visible to the naked eye	82
81	Parenchyma in the body of the growth ring clearly visible to the naked eye	83

82	Parenchyma in the body of the growth ring well-developed vasicentric to wide irregual confluent connecting 2–4 vessels	***Entandrophragma* spp.,** p. 73
82	Parenchyma in the body of the growth ring predominantly narrow vasicentric to slightly aliform; long tangential bands of wound tissue can be common	***Lovoa trichilioides,*** p. 88
83	Paratracheal parenchyma predominantly narrow vasicentric and narrow aliform, individual parenchyma cells too small to resolve with a hand lens	***Piptadeniastrum africanum,*** p. 104
83	Paratracheal parenchyma predominantly wide lozenge aliform, individual parenchyma cells typically visible with a hand lens	***Berlinia grandiflora,*** p. 48
84	Paratracheal parenchyma clearly visible with the hand lens but not clearly visible with the naked eye	85
84	Paratracheal parenchyma clearly visible with the naked eye	88
85	All rays distinctly less than half vessel width	86
85	At least some rays distintly wider than half the vessel width	87
86	Rays extremely narrow and abundant; parenchyma predominantly winged alifrom to narrow confluent; wood low density and soft	***Terminalia superba,*** p. 115
86	Rays narrow, average abundance; parenchyma predominantly narrow vasicentric; wood medium density	***Terminalia ivorensis,*** p. 115
87	Vessels predominantly solitary, sometimes in multiples of 2 and rarely 3; wood light brown and medium density	***Vitex micrantha,*** p. 121
87	Many vessels solitary and in multiples of 2–3 fairly common, multiples of 4–5 rare	***Antiaris toxicaria,*** p. 45
88	Paratracheal parenchyma narrow, the area of each vessel's parenchyma less than the vessel area	89
88	Paratracheal parenchyma wide, the area of each vessel's parenchyma clearly equal to or greater than vessel area	90
89	Paratracheal parenchyma narrow vasicentric, rarely narrow aliform; vessels sometimes in slight echelon, sometimes with reddish brown gums; wood medium density	***Zanthoxylum gilletii,*** p. 123
89	Paratracheal parenchyma winged aliform, short to medium wings; vessels often in clear echelon arrangement; wood high density and hard to cut with a utility knife	***Anopyxis klaineana,*** p. 43
90	Marginal parenchyma in fine, faint lines, common throughout the specimen	91
90	Marginal parenchyma absent or only faintly present in the minority of growth rings	93
91	Paratracheal parenchyma predominantly lozenge aliform with short, stubby wings	92
91	Paratracheal parenhcyma lozenge aliform with long wings to confluent connecting few vessels	***Parkia* spp.,** p. 101
92	Wood reddish brown	***Afzelia africana,*** p. 38
92	Wood brown, without reddish color	***Gilbertiodendron limba,*** p. 76
93	Paratracheal parenchyma predominantly vasicentric to narrow aliform	94
93	Paratracheal parenchyma predominantly aliform to confluent connecting few vessels	***Erythrophleum suaveolens,*** p. 74
94	Wood dark yellow-greenish brown to dark brown; medium-high density, often slightly resinous	***Cylicodiscus gabunensis,*** p. 64
94	Wood whitish to light reddish brown to rich red-brown; medium-low to medium density	***Albizia* spp.,** p. 40

7 | Species description pages

7.1 How to use the species description pages

These pages are written to be the final step in the identification process; you will be directed to them by the key in Chapter 6. Each species or group of similar species in the same genus has its own page. The information found in these pages shows transverse surface images of the wood and describes the characteristics of the wood for all species covered in the manual. Determine which character is present in the unknown, and use that information to confirm or deny the identification.

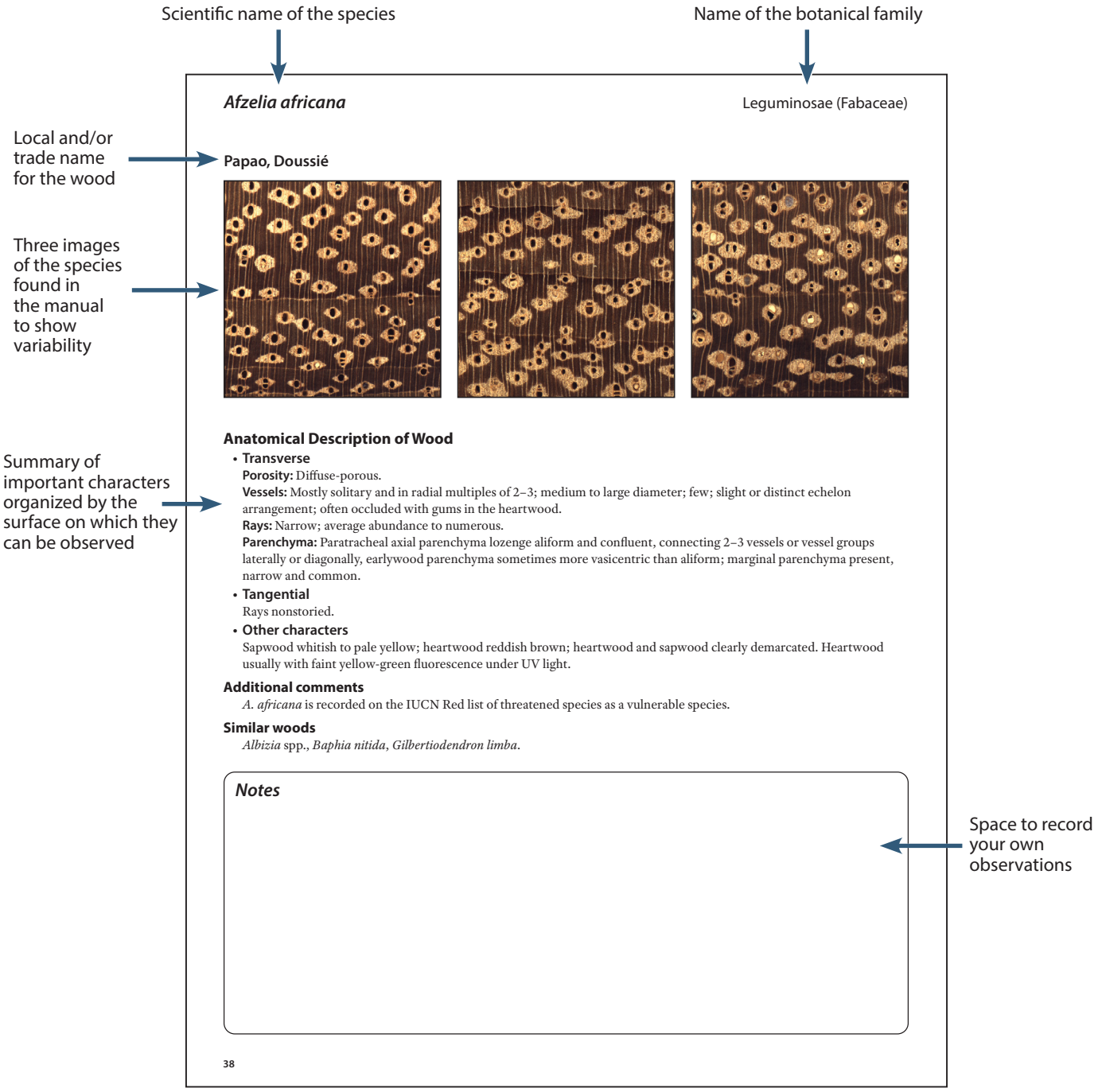
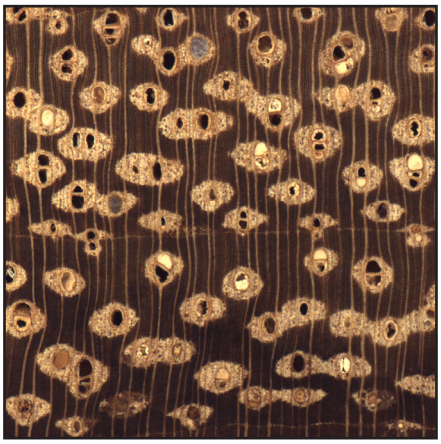


Figure 7.1—How to use the species description pages. Each wood in this manual has its own description page, and each page uses the same layout. For this reason, it is critical to familiarize yourself with this layout so that you can use the information efficiently. It is necessary to use these pages in combination with the key in Chapter 6, until you have the experience to recognize the pattern of each wood without the key. At that point, use these pages to confirm an identification.

Papao, Doussié





Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Mostly solitary and in radial multiples of 2–3; medium to large diameter; few; slight or distinct echelon arrangement; often occluded with gums in the heartwood.
  Rays: Narrow; average abundance to numerous.
  Parenchyma: Paratracheal axial parenchyma lozenge aliform and confluent, connecting 2–3 vessels or vessel groups laterally or diagonally, earlywood parenchyma sometimes more vasicentric than aliform; marginal parenchyma present, narrow and common.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood whitish to pale yellow; heartwood reddish brown; heartwood and sapwood clearly demarcated. Heartwood usually with faint yellow-green fluorescence under UV light.

Additional comments

A. africana is recorded on the IUCN Red list of threatened species as a vulnerable species.

Similar woods

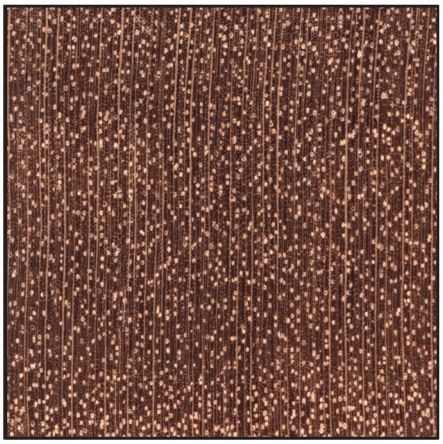
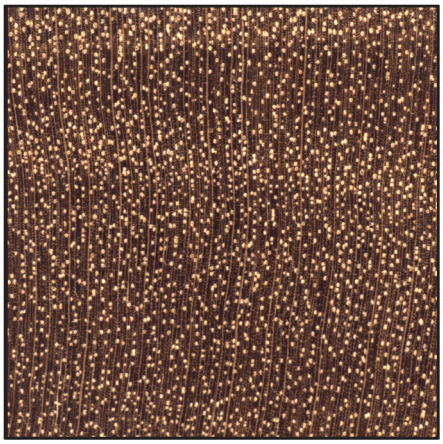
Albizia spp., *Baphia nitida*, *Gilbertiodendron limba*.

Notes

Aidia genipiflora
(Syn: *Randia genipiflora*)

Rubiaceae

Otwensono, Kwasoro

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Exclusively solitary; very small diameter (scarcely visible with a hand lens); abundant.
  Rays: Narrow and narrow-medium; numerous.
  Parenchyma: Apotracheal axial parenchyma diffuse and diffuse-in-aggregate, barely visible or not visible with a hand lens.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Heartwood light to dark brown and not clearly differentiated from the sapwood.

Additional comments

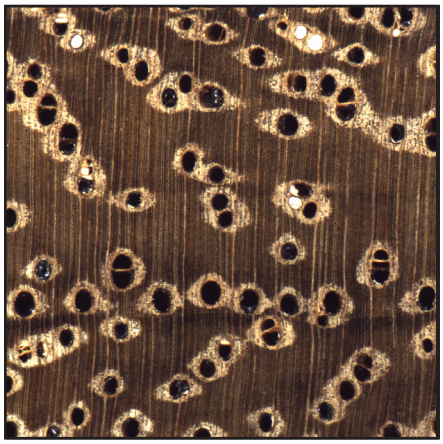
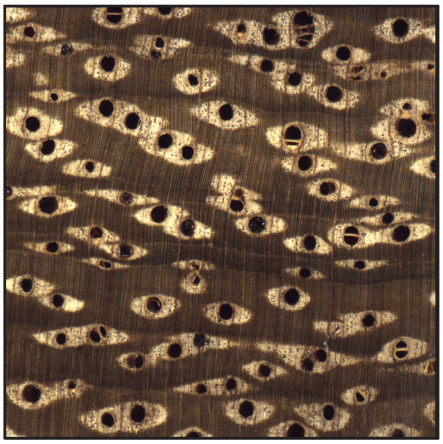
Based on the size of the vessels and rays and the difficulty of viewing the parenchyma, this wood has few observable features. *A. genipifllora* is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

Corynanthe pachyceras.

Notes

Pampena; Awiemfosamina; Okoro


Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Solitary and in radial multiples of 2–4; medium to large diameter; few; slight or distinct echelon arrangement; often occluded with dark gums in the heartwood.
  Rays: Narrow; average abundance.
  Parenchyma: Paratracheal axial parenchyma commonly wide vasicentric to lozenge aliform, sometimes confluent connecting 2–3 vessels or vessel groups laterally or sometimes diagonally; marginal parenchyma present, narrow, and common.
- **Tangential**
  Rays not storied.
- **Other characters**
  Heartwood commonly with streaks or color variations but not corresponding to growth rings.
  A. adianthifolia: sapwood white or white-yellow; heartwood golden-yellow or light-brown; heartwood and sapwood clearly demarcated; sometimes may have a greenish tinge.
  A. ferruginea: sapwood pale yellow; heartwood yellowish brown to dark brown, sometimes with purple streaks. Heartwood yellow-green fluorescent under UV light.
  A. zygia: sapwood white-yellow to grey; heartwood varies from pink to brown, yellow-brown or dark brown, sometimes with a red tinge. Heartwood yellow-green fluorescent under UV light.

Additional comments

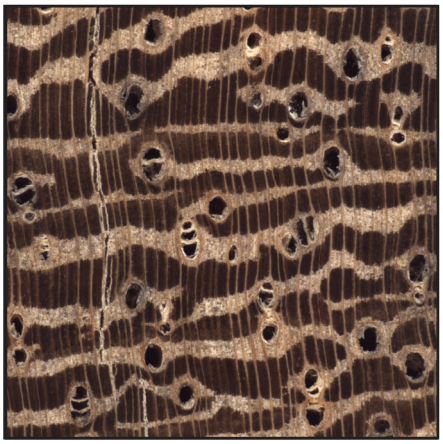
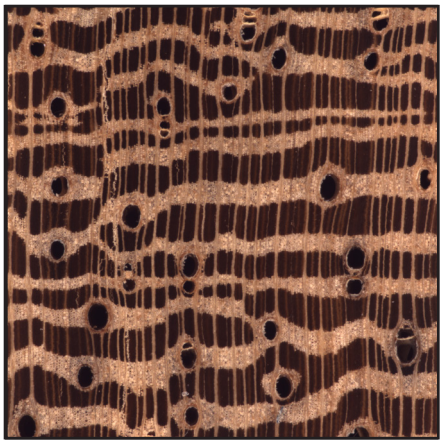
A. ferruginea is recorded on the IUCN Red list of threatened species as a vulnerable species.

Similar woods

Afzelia spp., *Baphia nitida, Cylicodiscus gabunensis, Gilbertiodendron limba*.

Notes

Yaya, Lati

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Solitary and in radial multiples of 2–4; medium to large diameter; few.
  Rays: Medium width; numerous.
  Parenchyma: Paratracheal axial parenchyma wide confluent connecting many vessels laterally and sometimes diagonally, most vessels in confluent band, few vessels with lozenge aliform; faint marginal parenchyma sometimes present.
- **Tangential**
  Rays irregularly storied, but fibers and vessels often storied, for an overall storied.
- **Other characters**
  Sapwood yellowish white; heartwood yellowish brown; heartwood and sapwood not clearly demarcated.

Additional comments

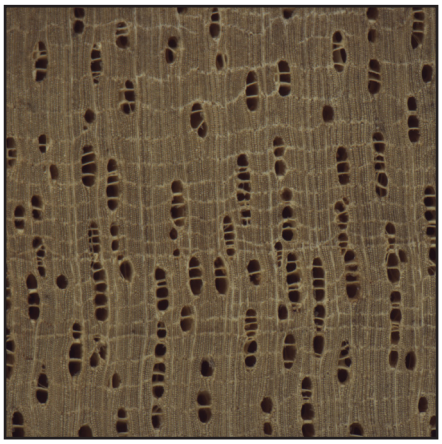
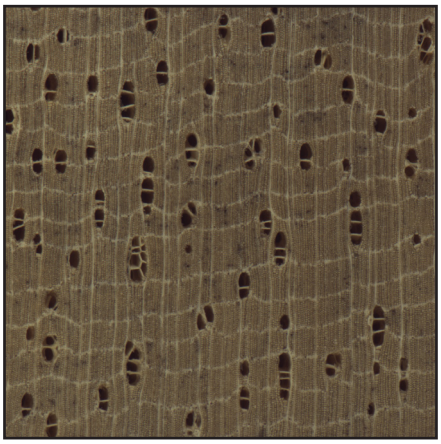
A. pterocarpoides is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

Lonchocarpus sericeus, Morinda lucida, *Morus mesozygia*.

Notes

Sinduro, Sinuro, Emien

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Solitary vessels rare, predominantly in radial multiples of 2–6 or more; medium to large diameter; few to medium abundance.
  Rays: Extremely narrow and difficult to see; average abundance.
  Parenchyma: Apotracheal axial parenchyma in long, narrow, widely spaced bands.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Heartwood yellowish white, darkening upon exposure to light; heartwood and sapwood not distinctly demarcated.

Additional comments

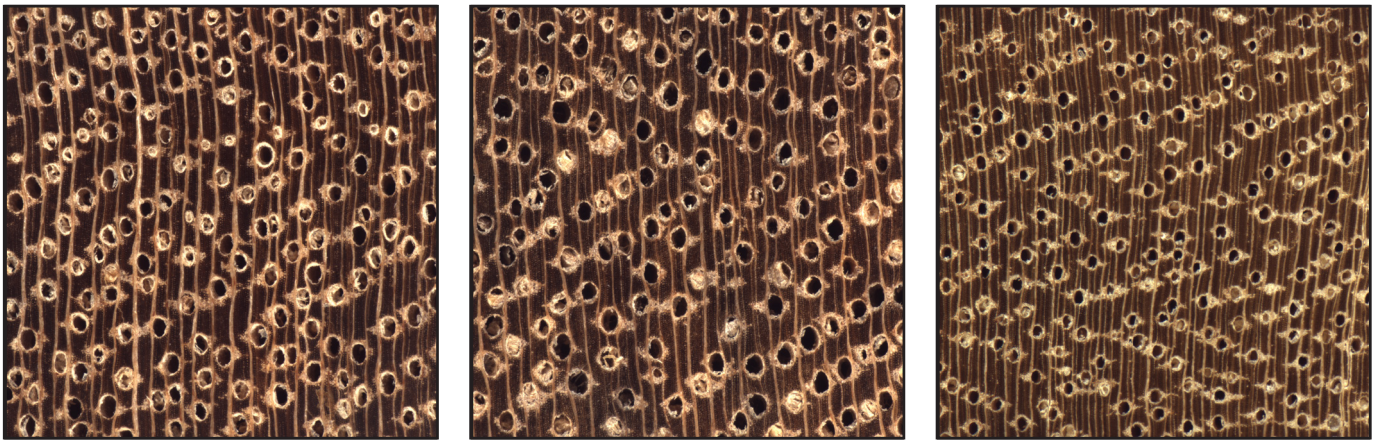
A. boonei is not recorded on the IUCN Red list of threatened species.

Similar woods

Woods in the Euphorbiaceae, such as *Hevea brasiliensis,* and other Apocynaceae.

Notes

Kokote, Badioa



Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Exclusively solitary; medium to large diameter; medium abundance; virtually all vessels in echelon arrangement.
  Rays: Narrow; numerous.
  Parenchyma: Paratracheal axial parenchyma narrow lozenge aliform and narrow winged-aliform, infrequently confluent connecting 2–3 vessels or vessel groups.
- **Tangential**
  Rays nonstoried. Ray cells with pigmented contents sometimes can be observed and can appear similar to, but are not, radial canals.
- **Other characters**
  Sapwood light yellowish brown; heartwood reddish brown or yellow-brown; heartwood and sapwood clearly demarcated.

Additional comments

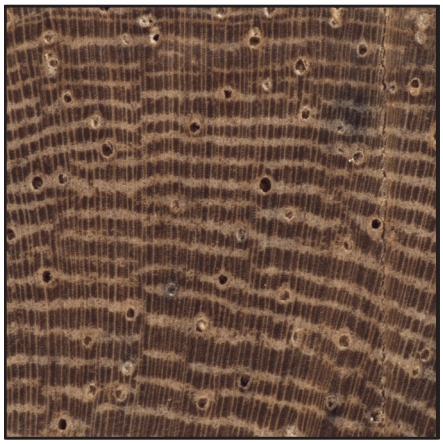
A. klaineana is recorded on the IUCN Red list of threatened species as a vulnerable species.

Similar woods

Celtis spp., *Zanthoxylum* spp., and some *Terminalia* spp.

Notes

Bontodee, Wudifokete



Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Mostly solitary and in multiples of 2–3; medium to large diameter; sparse.
  Rays: Narrow; extremely numerous.
  Parenchyma: Paratracheal axial parenchyma wide confluent connecting many vessels and extending tangentially in the absence of vessels. Vessels not in confluent parenchyma rare, typically vasicentric.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Heartwood creamy or yellowish white to brown or shades of brown. Wood somewhat lustrous.

Additional comments

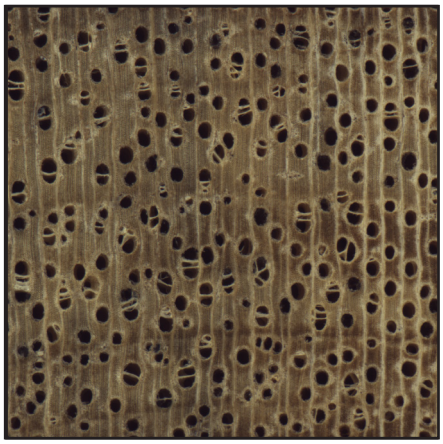
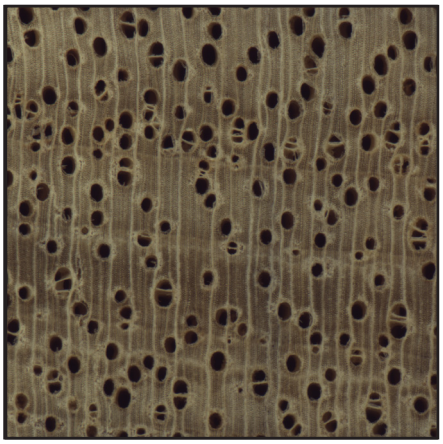
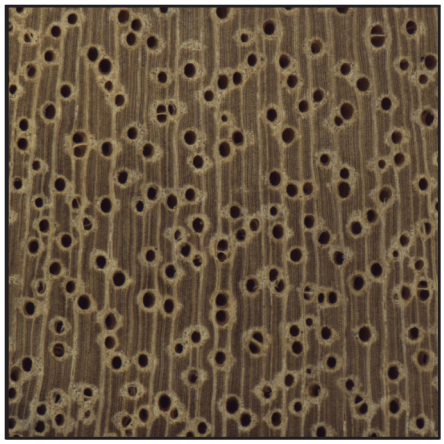
A. nobilis is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

Celtis spp.

Notes

Kyenkyen, Ako

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Mostly solitary, sometimes in radial multiples of 2–3; medium to large diameter; medium abundance; sometimes in echelon arrangement.
  Rays: Medium width; numerous.
  Parenchyma: Paratracheal axial parenchyma predominantly narrow vasicentric, narrow lozenge aliform, sometimes confluent connecting 2–3 vessels or vessel groups. The border between parenchyma and fibers is sometimes hazy or less sharp than in other woods.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  In some specimens, apparent growth rings are delineated by tangentially oriented areas lacking vessels.
  Heartwood white to light yellowish white and white to grey; heartwood and sapwood not demarcated.

Additional comments

A. toxicaria is not recorded on the IUCN Red list of threatened species.

Similar woods

Vitex micrantha.

Notes

Aprokuma, Onzabili



Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Solitary and some in radial multiples of 2–3; small to medium diameter; medium abundance.
  Rays: Narrow; average abundance.
  Parenchyma: Absent or extremely rare; sometimes in extremely faint marginal bands.
- **Tangential**
  Rays nonstoried; radial canals present in some of the rays, making those rays very conspicuous.
- **Other characters**
  Sapwood greyish white; heartwood pinkish white to red-brown; heartwood and sapwood hardly demarcated.

Additional comments

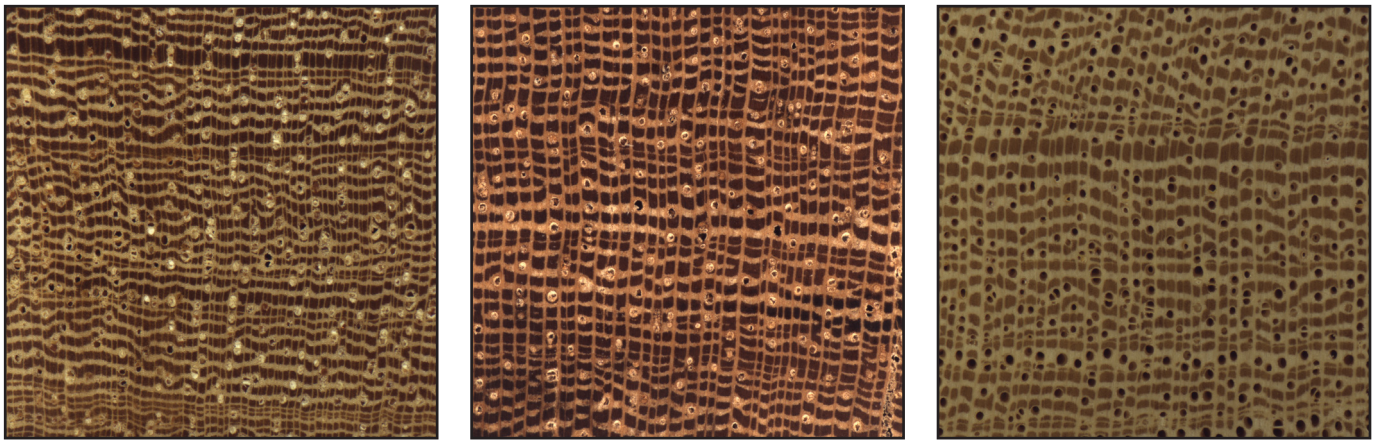
A. micraster is recorded on the IUCN Red list of threatened species as a vulnerable species.

Similar woods

Pycnanthus angolensis and *Lannea welwitschii*.

Notes

Odwen, Abolooba



Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Mostly solitary; small to medium diameter; few.
  Rays: Narrow; numerous.
  Parenchyma: Paratracheal axial parenchyma predominantly narrow confluent connecting many vessels; faint and narrow marginal parenchyma often present.
- **Tangential**
  Rays, vessels, and fibers storied.
- **Other characters**
  Sapwood yellowish white, often with an unpleasant smell; heartwood pale brown when fresh, turning to dark red or orange upon exposure; yields a red dye. The wood is hard and high density.

Additional comments

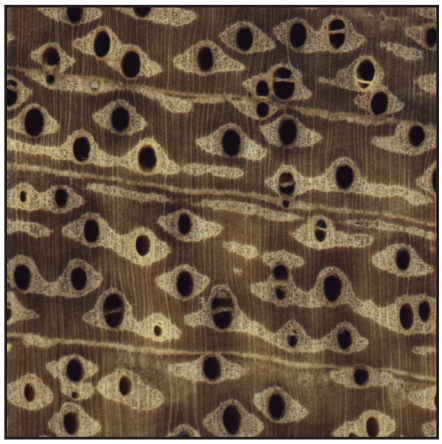
B. nitida is recorded on the IUCN Red list of threatened species as a species of least concern.

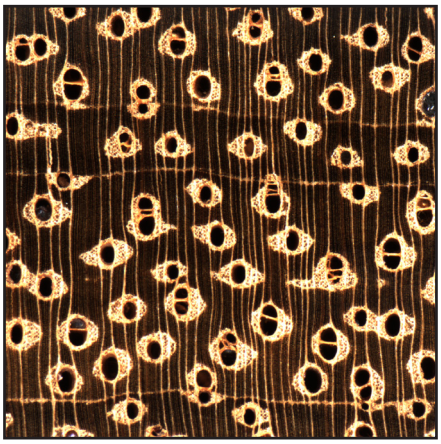
Similar woods

Afzelia spp., *Albizia* spp., *Gilbertiodendron limba*.

Notes

Kwatafompaboa, Berlinia, Ebiara





Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Mostly solitary; medium to large diameter; few; slight or distinct echelon arrangement; some occluded with gums in the heartwood.
  Rays: Narrow; numerous.
  Parenchyma: Paratracheal axial parenchyma lozenge aliform, winged-aliform, and occasionally confluent, commonly connecting 2–3 vessels; marginal parenchyma present.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood whitish to pinkish, with a thickness of 10–15 cm; heartwood pinkish brown to dark red-brown with dark brown or purple streaks.

Additional comments

B. grandiflora is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

Piptadeniastrum africanum.

Notes

Akye, Akee, Tsana



Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Mostly solitary and in radial multiples of 2–6; medium diameter; few to medium; occasionally white deposits in the heartwood.
  Rays: Narrow; numerous.
  Parenchyma: Paratracheal axial parenchyma absent.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood whitish; heartwood is orange-brown to reddish brown; heartwood and sapwood distinctly demarcated.

Additional comments

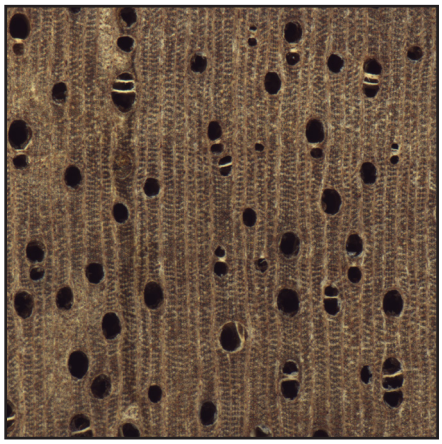
B. sapida is not recorded on the IUCN Red list of threatened species.

Similar woods

Khaya spp.

Notes

Akata, Akonkodie, Onyinakoben, Bombax



Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Mostly solitary and in multiples of 2–3; large diameter; sparse.
  Rays: Wide; few.
  Parenchyma: Apotracheal axial parenchyma diffuse-in-aggregate.
- **Tangential**
  Axial parenchyma elements storied in *B. buonopozense*, rays coarsely storied in *B. brevicuspe*.
- **Other characters**
  Heartwood whitish to pinkish grey; heartwood and sapwood not clearly demarcated.

Additional comments

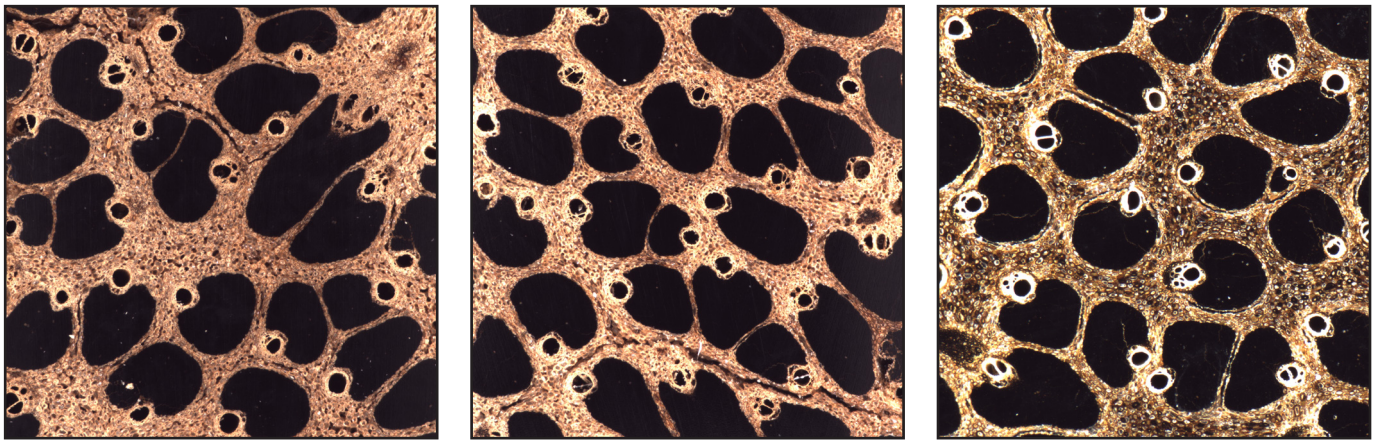
Bombax buonopozense tends to have more exclusively solitary vessels; the axial elements—but not the rays—are storied and the wood has a lower density than *B. brevicuspe*, which has a higher density, has clearly storied rays, and has more frequent radial vessel multiples and tangentially arranged vessel clusters. *B. brevicuspe* is recorded on the IUCN Red list of threatened species as vulnerable, and *B. buonopozense* is listed as a species of least concern.

Similar woods

Other Malvaceae such as *Ceiba pentandra* and *Triplochiton scleroxylon*.

Notes

Mmakube



Anatomical Description of Wood

- **Transverse**
  Being a monocot, growth rings, sapwood, and rays are completely absent. Uniform distribution of black fibrovascular bundles typically with one large (sometimes two) vessel per bundle and from 0 to 4 or 5 small vessels, all of which are embedded in a softer yellow-brown body of parenchyma; fibrovascular bundles occupy the majority of the space.
- **Other characters**
  "Wood" coarse to medium texture, though not uniform. "Wood" extremely dense and dark brown to black.

Additional comments

Borassus aethiopum is much harder, heavier, and darker in color than *Cocos nucifera. B. aethiopum* is recorded on the IUCN Red list of threatened species as a species of least concern.

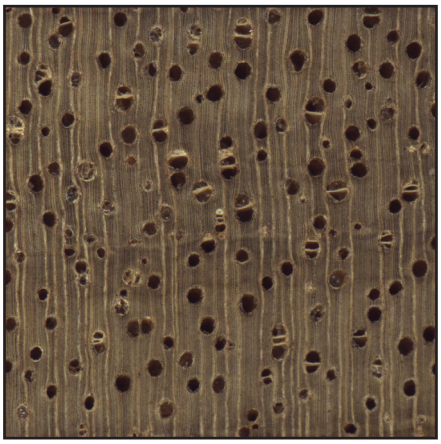
Similar woods

Cocos nucifera.

Notes

Bediwonua, Abel, Eyere, Aiélé





Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Mostly solitary, some in radial multiples of 2–4; some in subtle to distinct echelon arrangement; medium to large diameter; few to medium abundance; tyloses common.
  Rays: Narrow; average to few.
  Parenchyma: Axial parenchyma absent.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood white to pale yellow and has a thickness of up to 10 cm; heartwood pale pinkish brown to light pinkish yellow; heartwood and sapwood not clearly demarcated.

Additional comments

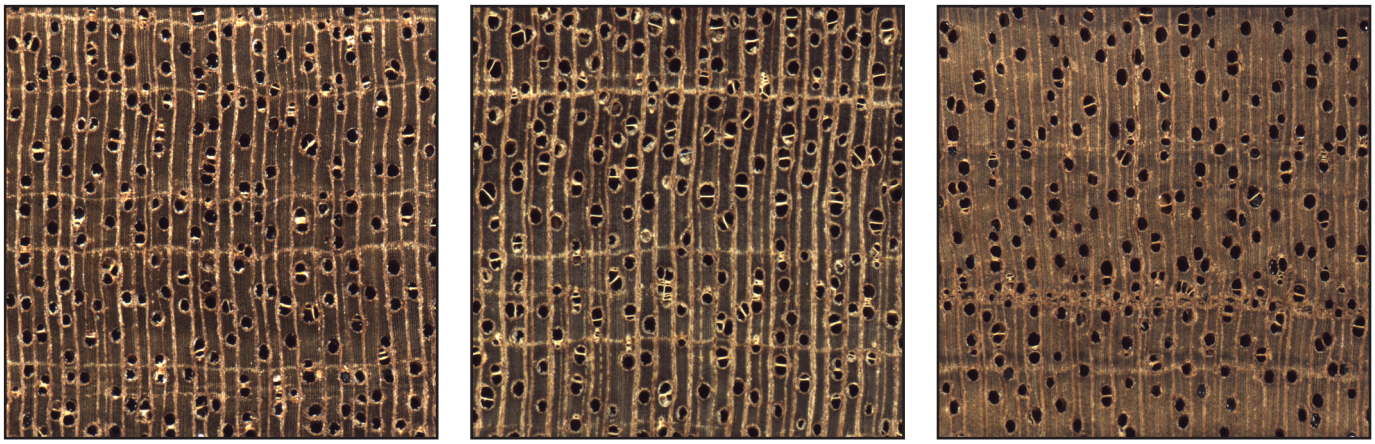
C. schweinfurthii is not recorded on the IUCN Red list of threatened species.

Similar woods

Turraeanthus africanus.

Notes

Kwakuo-bese, Krupi, Andiroba



Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Mostly solitary, some in radial multiples of 2–4; medium diameter; medium abundace; some vessels in echelon arrangement; some with dark-colored deposits in the heartwood.
  Rays: Narrow and wide; average abundance.
  Parenchyma: Apotracheal axial parenchyma absent; paratracheal axial parenchyma absent or appearing as faint vasicentric. Marginal parenchyma often present.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood distinct; heartwood golden red-brown in color.

Additional comments

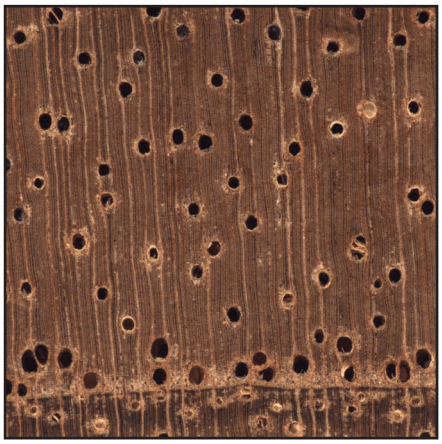
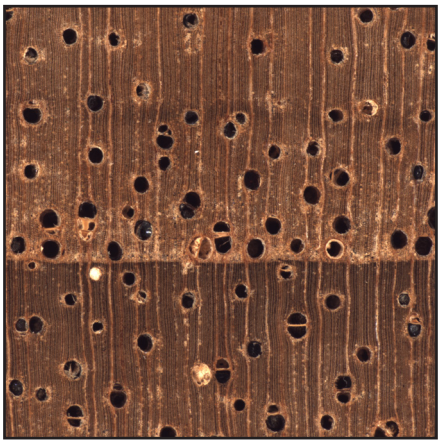
C. procera is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

Khaya spp.

Notes

Cedrela, Cedro

Anatomical Description of Wood

- **Transverse**
  Porosity: Wood typically semi-ring-porous, sometimes ring-porous.
  Vessels: Solitary and in multiples of 2–4; medium diameter; few to medium abundance; frequently with dark gums in the heartwood.
  Rays: Narrow to medium width; average abundance.
  Parenchyma: Apotracheal axial parenchyma diffuse. Paratracheal axial parenchyma scanty and/or faintly vasicentric. Marginal parenchyma present and typically associated with the earlywood vessels.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood pale pink in color; heartwood ranges from light brown to reddish brown. Heartwood typically has a pleasant sweet to spicy odor.

Additional comments

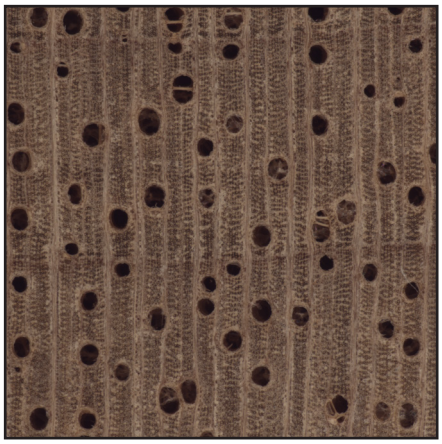
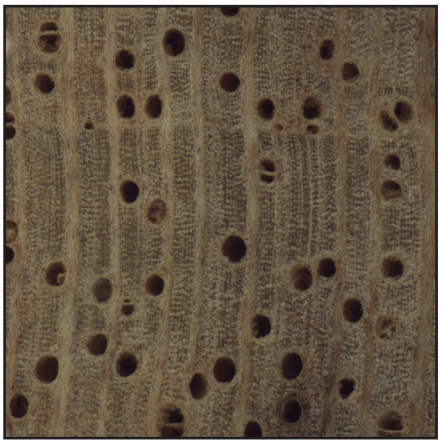
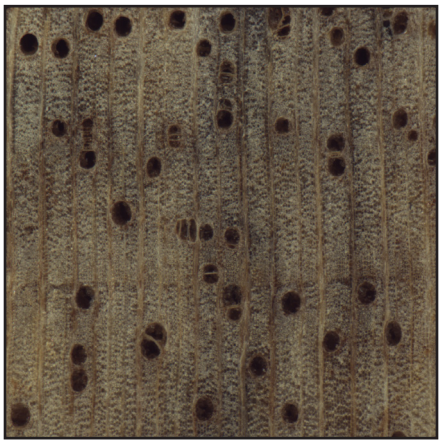
The marginal parenchyma in *Cedrela* is typically wide, with a distinct transition border on the latewood side (between growth rings) and a less distinct transition to fibers and vessels on the earlywood side; the large earlywood vessels are often embedded in the marginal parenchyma but this does not appear as confluent parenchyma. This species is not native to Ghana and is grown in plantation, often giving rise to fast-grown timber with wide growth rings.

Similar woods

Tectona grandis shows similar ring-porosity.

Notes

Onyina, Ceiba

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Vessels solitary, in multiples of 2–3, and in subtle to distinct echelon arrangement; large diameter; few; tyloses common.
  Rays: Wide to extremely wide; fairly numerous.
  Parenchyma: Apotracheal axial parenchyma diffuse-in-aggregate.
- **Tangential**
  Rays nonstoried, but axial parenchyma storied.
- **Other characters**
  Sapwood pale white; heartwood variable in color, from pale yellow to light brown, often with greyish veins; heartwood and sapwood not clearly demarcated.

Additional comments

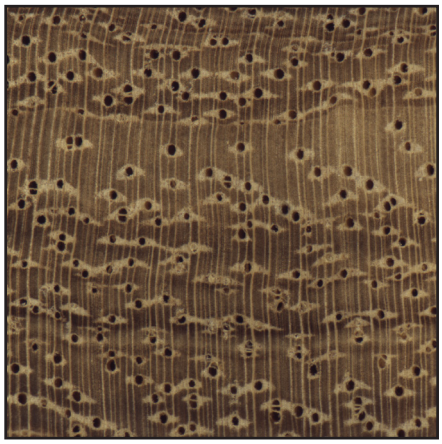
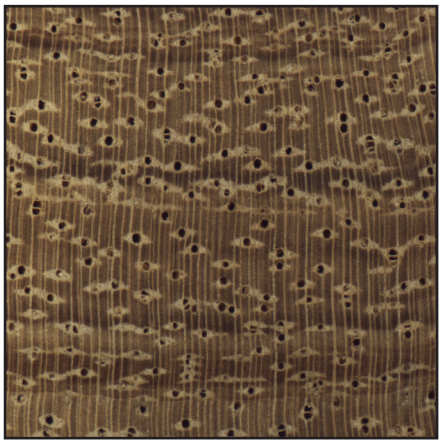
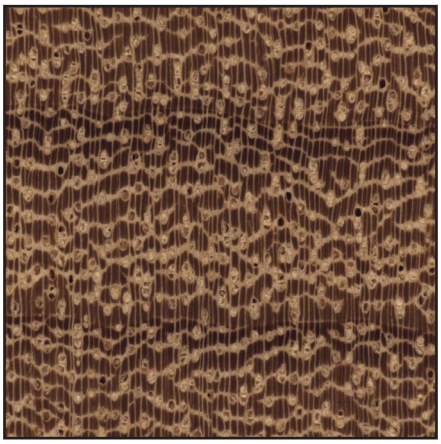
C. pentandra is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

Other Malvaceae, especially *Bombax* spp.

Notes

Esa, Esakosua; Esa-fufuo; Esa-kokoo

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Mostly solitary and in multiples of 2–3; medium to small diameter; medium abundance; tyloses common; occasionally with white deposits in the heartwood.
  Rays: Narrow to medium size; average abundance.
  Parenchyma: Paratracheal axial parenchyma lozenge and winged aliform and/or narrow confluent connecting many vessels, often only found on one side of the vessel; marginal parenchyma faint when present.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood yellowish white; heartwood creamy white to pale yellow to light brown; heartwood and sapwood not distinctly demarcated.

Additional comments

All three species are recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

Anthocleista nobilis.

Notes

Akasaa; Atabene



Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Radial multiples of 4 or more common; multiples sometimes with slight radial or echelon arrangement, small to medium diameter; medium abundance.
  Rays: Narrow; numerous.
  Parenchyma: Apotracheal axial parenchyma in closely spaced narrow wavy bands .
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Heartwood yellowish or pinkish white to brownish yellow; heartwood and sapwood indistinctly demarcated.

Additional comments

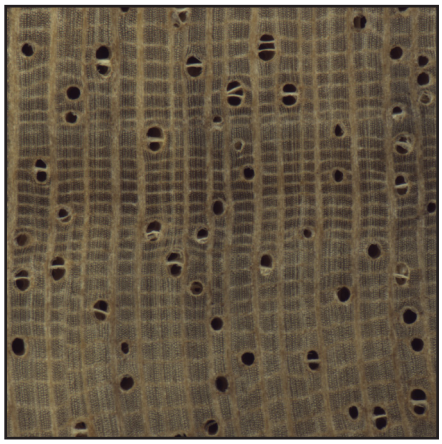
Neither species is recorded on the IUCN Red list of threatened species.

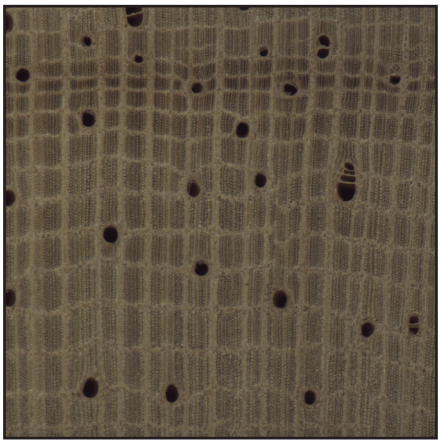
Similar woods

Other Sapotaceae, such as *Manilkara*, *Pouteria, Tieghemella* spp.

Notes

Ngonenkyene





Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Mostly solitary, some in radial multiples of 2–4; medium to large diameter; sparse.
  Rays: Mostly medium; average abundance.
  Parenchyma: Paratracheal axial parenchyma absent or faintly vasicentric; apotracheal axial parenchyma in narrow, irregular widely spaced bands.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Heartwood whitish; heartwood and sapwood not clearly demarcated.

Additional comments

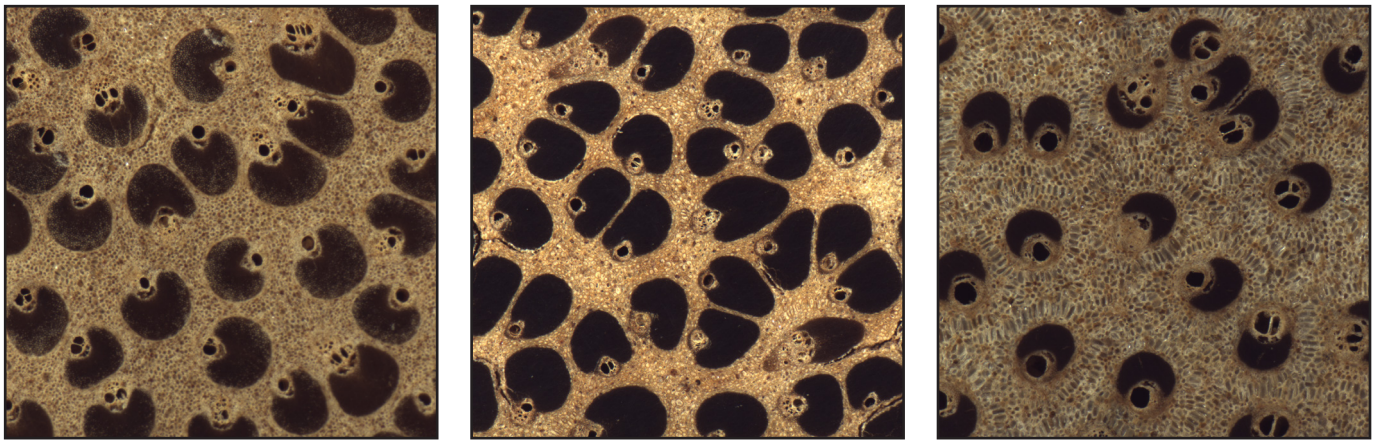
The local name "Ngononkyene" is also used for *Morinda lucida* in some communities in Ghana. *C. patens* is not recorded on the IUCN Red list of threatened species.

Similar woods

Duguetia staudtii.

Notes

Kube



Anatomical Description of Wood

- **Transverse**
  Being a monocot, growth rings, sapwood, and rays are completely absent. Uniform distribution of black fibrovascular bundles typically with one large (sometimes two) vessel per bundle and from 0 to 4 or 5 small vessels, all of which are embedded in a softer whitish-brown body of parenchyma; fibrovascular bundles occupying roughly half the space.
- **Other characters**
  "Wood" coarse to medium texture, though not uniform. "Wood" moderately dense, lightish brown with dark brown streaks.

Additional comments

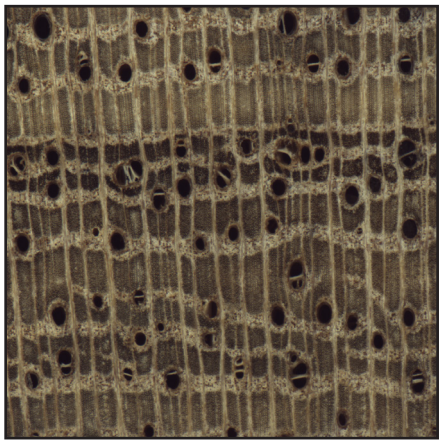
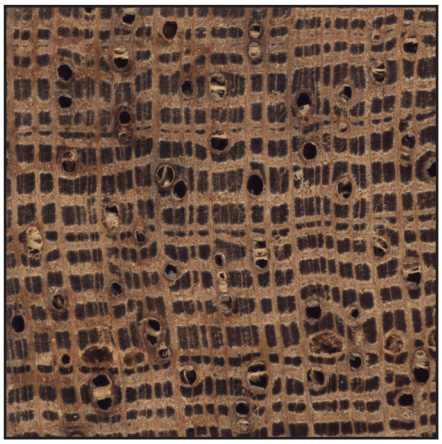
Cocos nucifera is much lighter and softer and lighter in color than *Borassus aethiopum. C. nucifera* is not recorded on the IUCN Red list of threatened species.

Similar woods

Borassus aethiopum.

Notes

Watapuo, Dodowa


Anatomical Description of Wood

- **Transverse**
  Porosity: Wood diffuse-porous.
  Vessels: Mostly solitary and in multiples of 2–3; medium to large diameter; sparse to few.
  Rays: Medium to medium-wide; numerous.
  Parenchyma: Paratracheal axial parenchyma narrow vasicentric and confluent in wide bands, intergrading with banded apotracheal parenchyma often intersecting vessels. Marginal parenchyma thin and faint when present.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Heartwood shades of brown, yellow, or white to grey.

Additional comments

C. gigantea is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

Entada abyssinica.

Notes

Entedua, Etimoé

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Mostly solitary, few multiples of 2–3; medium diameter; few.
  Rays: Narrow to narrow-medium width; average abundance.
  Parenchyma: Apotracheal axial parenchyma absent. Marginal parenchyma common, sometimes with appearance of small vessels with dark contents. Paratracheal axial parenchyma vasicentric to narrow lozenge aliform.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood paler than the heartwood; heartwood reddish brown or grey with a pink hue; heartwood and sapwood clearly demarcated. Heartwood usually with faint yellow-green fluorescence under UV light.

Additional comments

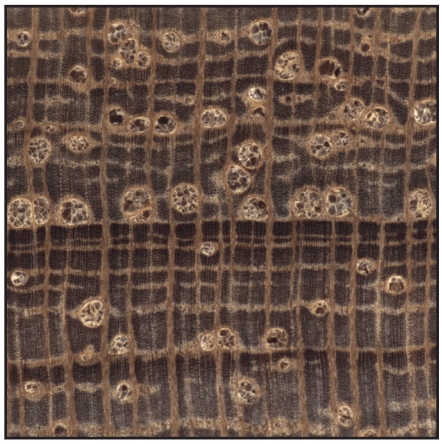
C. salikounda is recorded on the IUCN Red list of threatened species as a vulnerable species.

Similar woods

Entandrophragma spp., *Lovoa trichilioides*.

Notes

Tweneboa, Cordia



Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Mostly solitary, some in radial to tangential multiples of 2–3, medium to large diameter; few; tyloses abundant.
  Rays: Medium width to wide; average abundance.
  Parenchyma: Apotracheal axial parenchyma in thin to thick irregular bands, grading into paratracheal confluent bands. Marginal parenchyma faint when present, often just external to a band of thicker-walled fibers.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Heartwood pale brown to brown, occasionally pinkish brown; heartwood and sapwood clearly demarcated.

Additional comments

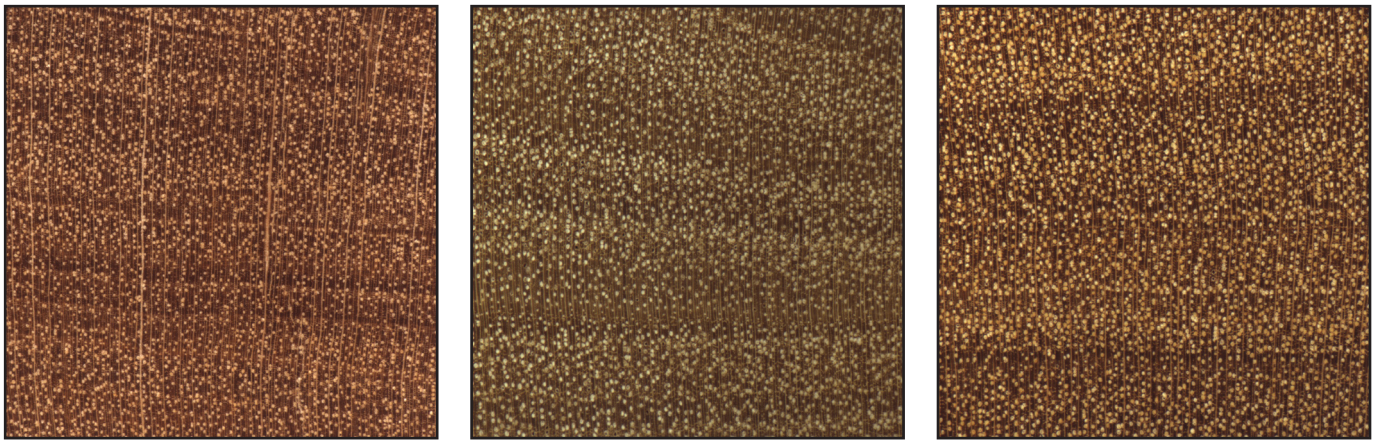
C. millennii is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

Tarrietia utilis.

Notes

Pampenama



Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous. Apparent growth rings sometimes suggested by areas of fewer vessels and thicker-walled fibers.
  Vessels: Exclusively solitary; very small diameter; extremely abundant.
  Rays: Narrow; numerous.
  Parenchyma: Apotracheal axial parenchyma diffuse and/or diffuse in aggregates. Paratracheal axial parenchyma absent. Marginal parenchyma absent or extremely faint.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Heartwood pale pink with yellow tinge, turning yellow-brown with age; heartwood and sapwood not demarcated. The wood is hard and heavy.

Additional comments

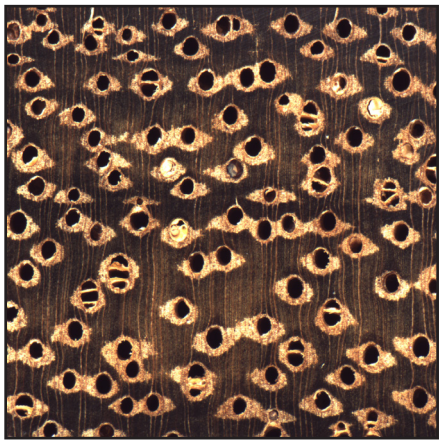
C. pachyceras is recorded on the IUCN Red list of threatened species as a species of least concern.

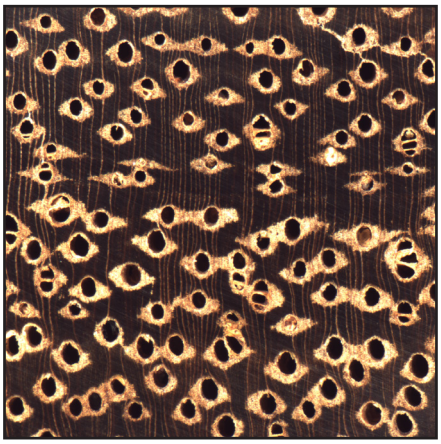
Similar woods

Aidia genipiflora.

Notes

Denya, Okan





Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous. Apparent growth rings sometimes suggested by areas of fewer vessels and thicker-walled fibers.
  Vessels: Mostly solitary or in multiples of 2; medium to large diameter; few.
  Rays: Narrow; numerous.
  Parenchyma: Paratracheal axial parenchyma narrow vasicentric, and/or lozenge aliform with short wings.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood pale pink; heartwood yellow-brown to golden brown, often with a slight greenish tinge; heartwood and sapwood clearly demarcated. The wood is slightly lustrous.

Additional comments

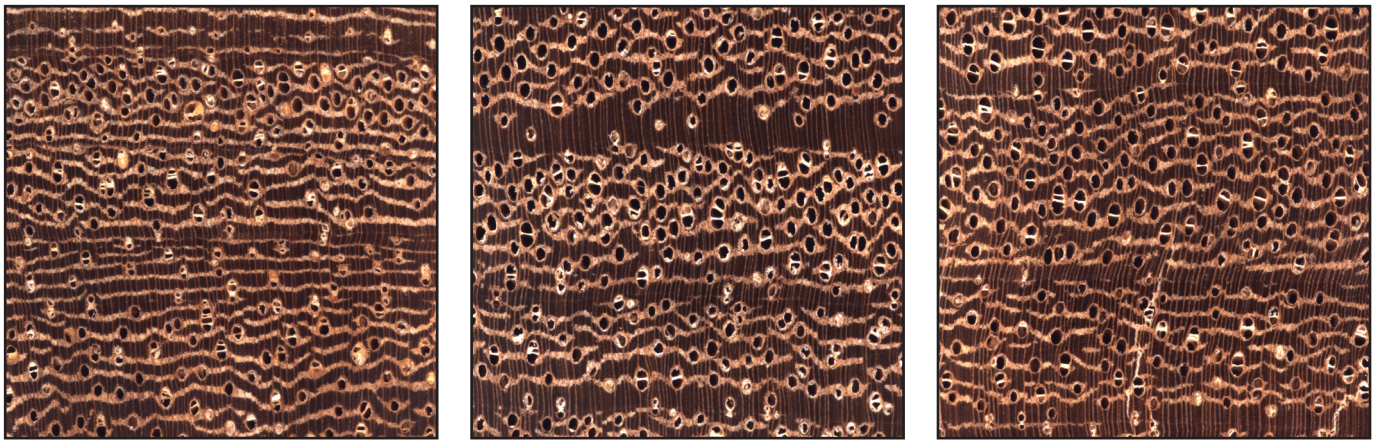
C. gabunensis is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

Afzelia spp., *Albizia* spp., *Baphia nitida, Gilbertiodendron limba*.

Notes

Ananta, Apomé



Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous. Apparent growth rings sometimes suggested by areas of fewer vessels and thicker-walled fibers.
  Vessels: Mostly solitary and in radial multiples of 2–3; medium to small diameter; abundant.
  Rays: Extremely narrow; numerous.
  Parenchyma: Apotracheal axial parenchyma in narrow, abundant bands intergrading with paratracheal confluent axial parenchyma.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood pink-brown or yellow; heartwood dark red-brown with fine markings; heartwood and sapwood clearly demarcated.

Additional comments

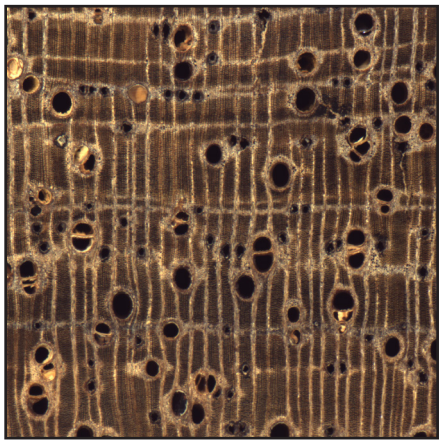
C. ananta is not recorded on the IUCN Red list of threatened species.

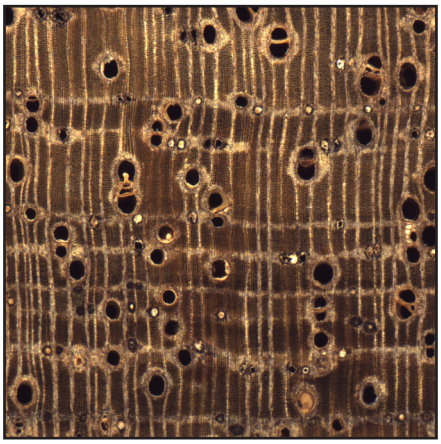
Similar woods

Guarea cedrata.

Notes

Hyedua, Sopi, Faro; Hyedua-nin, Senya





Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Mostly solitary and in multiples of 2–4; mostly large to very large diameter; sparse. Much smaller, apparently gum-filled vessels also present.
  Rays: Medium width; average abundance.
  Parenchyma: Paratracheal axial parenchyma vasicentric and lozenge aliform and confluent connecting few vessels. Apotracheal axial parenchyma in irregular bands. Marginal parenchyma present in narrow bands.
- **Tangential**
  All rays storied.
- **Other characters**
  Sapwood whitish; heartwood pale pinkish brown to reddish brown with occasional darker streaks; heartwood and sapwood clearly demarcated.

Additional comments

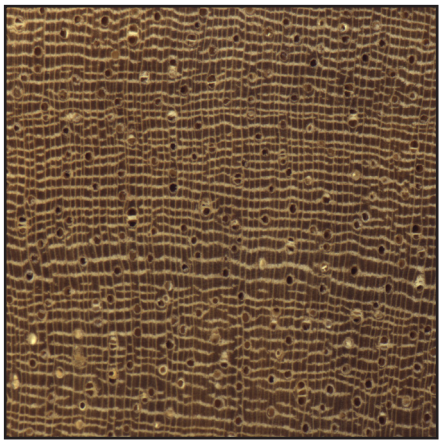
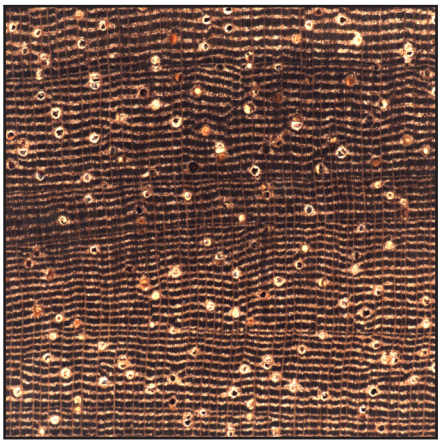
The local name "Hyedua" is also used for *Guibourtia ehie* in some communities in Ghana. *D. ogea* is not recorded on the IUCN Red list of threatened species, and *D. oliveri* is recorded as a species of least concern.

Similar woods

Entandrophragma spp.

Notes

Duobankye, Eyoum


Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous. Apparent growth rings sometimes suggested by areas of fewer vessels and thicker-walled fibers.
  Vessels: Mostly solitary and in multiples of 2; narrow diameter; sparse.
  Rays: Extremely narrow; average abundance.
  Parenchyma: Apotracheal axial parenchyma in numerous narrow irregular bands.
- **Tangential**
  All rays medium storied.
- **Other characters**
  Sapwood whitish; heartwood dark pink-brown, dark red, or sometimes very dark; heartwood and sapwood clearly demarcated. The wood is heavy.

Additional comments

D. aubrevillei is not recorded on the IUCN Red list of threatened species.

Similar woods

Diospyros kamerunensis.

Notes

African Ebony, Omenewa, Kusibiri, Kaqui, Atwea

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Mostly solitary and in short radial multiples; small diameter; few.
  Rays: Extremely narrow; numerous.
  Parenchyma: Apotracheal axial parenchyma in very thin and/or narrow continuous tangential bands.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood pinkish; heartwood black-brown in *D. kamerunensis* and light brown in *D. viridicans*; heartwood and sapwood clearly demarcated. The wood is heavy, hard, and tough.

Additional comments

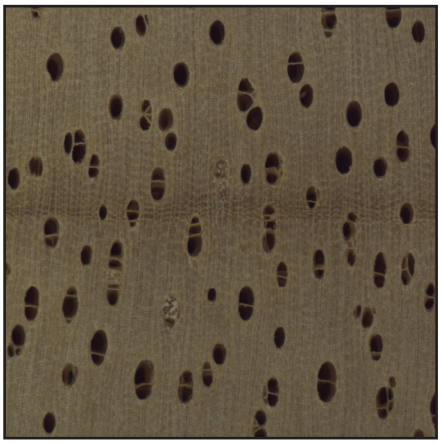
Neither *D. kamerunenis* nor *D. viridicans* is recorded on the IUCN Red list of threatened species.

Similar woods

Dialium aubrevillei; Sapotaceae, such as *Pouteria, Chrysophyllum, Manilkara*, and *Tieghemella* spp.

Notes

Fetefre, Akoret


Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Mostly solitary and in short radial multiples of 2–4; medium to large diameter; few.
  Rays: Narrow; average abundance.
  Parenchyma: Apotracheal axial parenchyma diffuse-in-aggregate.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Heartwood whitish or pale yellow to yellowish brown; heartwood and sapwood indistinctly demarcated. The wood is light in weight and soft.

Additional comments

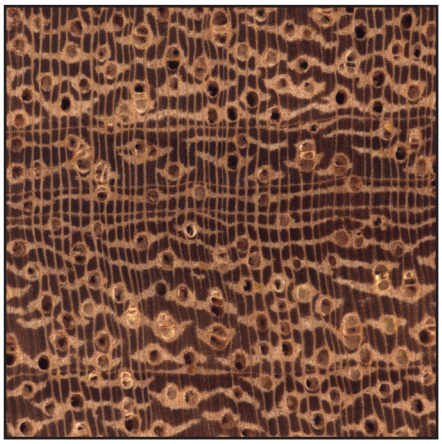
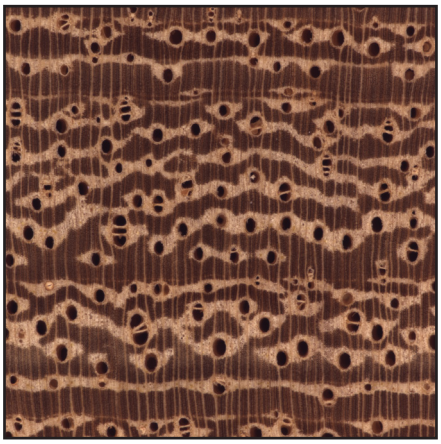
D. caloneura is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

Difficult to discriminate from *Ricinodendron heudelotii*.

Notes

Bonsamdua, Ayan, Movingui

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous. Apparent growth rings sometimes suggested by areas of fewer vessels and thicker-walled fibers.
  Vessels: Mostly solitary and some in short radial multiples of 2–3; medium diameter; medium abundance.
  Rays: Narrow to narrow-medium width; average abundance.
  Parenchyma: Paratracheal axial parenchyma lozenge aliform, winged-aliform and confluent connecting few vessels; marginal parenchyma present and extremely narrow.
- **Tangential**
  All rays storied.
- **Other characters**
  Sapwood whitish to straw-yellow, 2–4 cm wide; heartwood yellow to yellowish brown; heartwood and sapwood clearly demarcated. The wood is moderately hard and slightly lustrous.

Additional comments

D. benthamianus is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

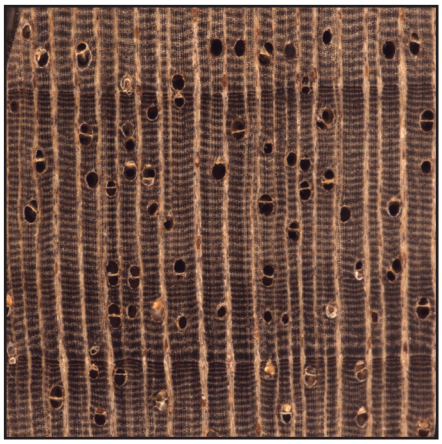
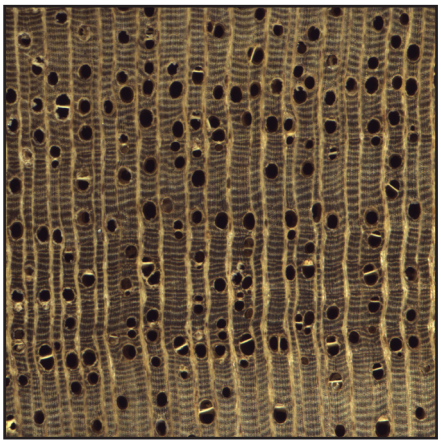
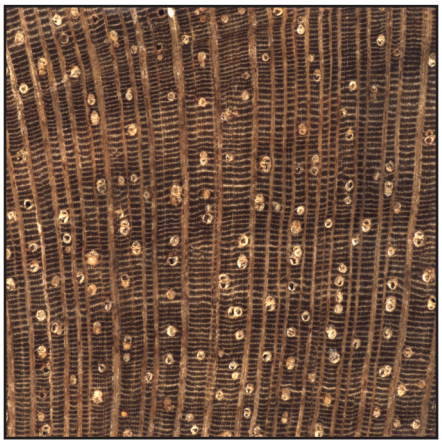
Pericopsis elata.

Notes

Duguetia staudtii
(Syn: *Pachypodanthium staudtii*)

Annonaceae

Kumdwie, Fale

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous; apparent growth rings sometimes suggested by thicker-walled fibers.
  Vessels: Mostly solitary, some radial multiples mostly of 2, sometimes in small clusters; medium diameter; few to medium abundance; gums and other deposits in heartwood vessels.
  Rays: Medium to wide; average abundance.
  Parenchyma: Apotracheal axial parenchyma in long, narrow, regular bands.
- **Tangential**
  Rays nonstoried. Typically light brown radial canals present.
- **Other characters**
  Heartwood yellow-brown to red-brown, with occasional olive tinge stripes; heartwood and sapwood not clearly demarcated.

Additional comments

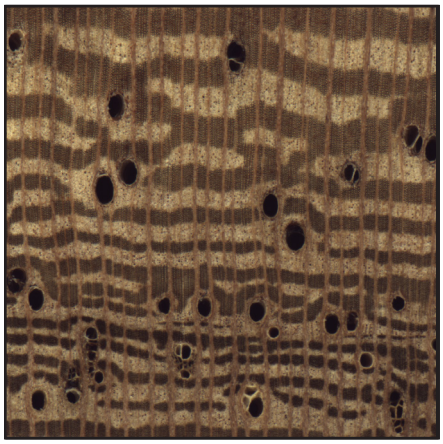
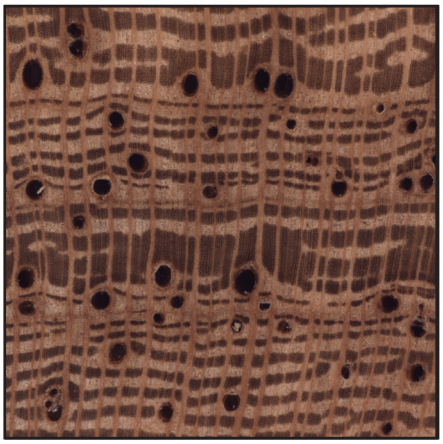
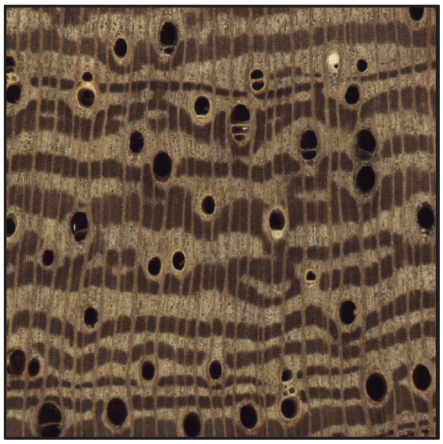
D. staudtii is not recorded on the IUCN Red list of threatened species.

Similar woods

Cleistopholis patens.

Notes

Chienchienga

Anatomical Description of Wood

- **Transverse**
  Porosity: Mostly diffuse-porous to faintly (but commonly) semi-ring-porous.
  Vessels: Mostly solitary and some in short radial multiples of 2–4; large diameter; sparse.
  Rays: Medium width to medium-wide; few to average.
  Parenchyma: Paratracheal axial parenchyma wide and confluent intergrading with wide, irregular banded apotracheal axial parenchyma. Wide patches of irregular apotracheal parenchyma common.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Wood pale brown, occasionally tinged with pink. It is soft and moderately light.

Additional comments

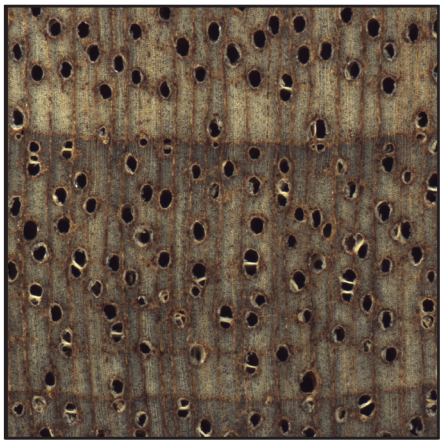
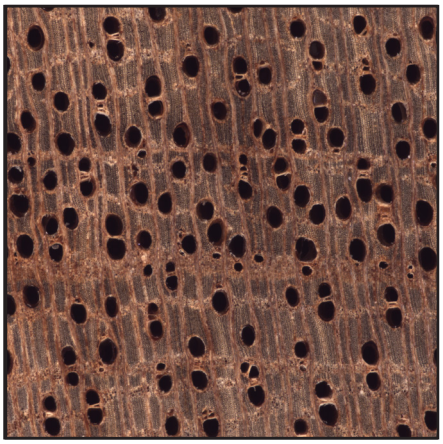
E. abyssinica is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

Cola gigantea.

Notes

Edinam, Tiama; Penkwa-akoa, Kosipo; Penkwa, Sapele; Efoobrodedwo, Utile, Sipo


Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Solitary and in multiples of 2–4; medium to large diameter; few to medium in abundance; brown-colored deposits in heartwood.
  Rays: Medium width; average abundance.
  Parenchyma: Paratracheal axial parenchyma scanty to incomplete vasicentric in some specimens, and vasicentric to aliform to confluent in others; apotracheal axial parenchyma in narrow to wide wavy and sometimes incomplete bands; marginal parenchyma typically present.
- **Tangential**
  Rays typically coarsely storied in *E. cylindricum,* but some specimens range from irregularly storied to not storied. Rays never well storied in the remaining three species, and only rarely irregularly storied in *E. angolense* and *E. candollei* but more commonly weakly and irregularly storied in *E. utile*.
- **Other characters**
  Sapwood creamy white to pale pinkish; heartwood pale brown to pale reddish brown, slightly darkening upon exposure to deep reddish brown with golden shades; heartwood and sapwood distinctly demarcated. The wood is light in weight and moderately soft and moderate in luster.

Additional comments

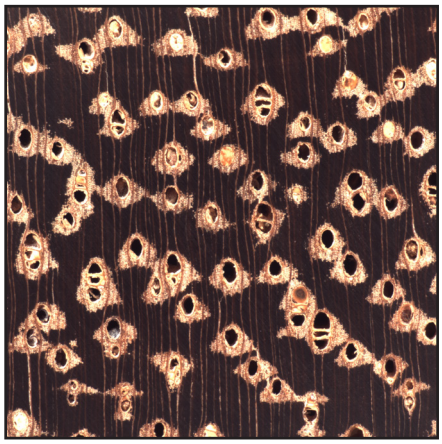
The anatomical variability within these species, and in the genus overall, is quite high. Different individuals of the same species can show different combinations of patterns. *E. cylindricum* typically has a pleasant, spicy odor that is lacking in the other species. When a specimen has both well-storied rays and a spicy aroma, it is quite likely to be *E. cylindricum*. Positive identification of the other species with only a hand lens is probably guesswork. All four species are recorded on the IUCN Red list of threatened species as vulnerable.

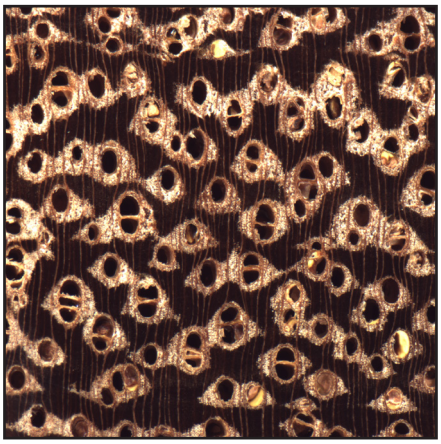
Similar woods

Lovoa trichilioides.

Notes

Potrodom, Tali





Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Mostly solitary and in radial multiples of 2–3; medium to large diameter; few to abundant; commonly in echelon arrangement; sometimes with light-colored deposits.
  Rays: Very narrow to narrow; average abundance.
  Parenchyma: Paratracheal axial parenchyma vasicentric, aliform, lozenge aliform, and confluent connecting many vessels, often in echelon confluences.
- **Tangential**
  Rays irregularly storied to not storied.
- **Other characters**
  Sapwood creamy-yellowish; heartwood yellow-brown to red-brown, darkens on exposure; heartwood and sapwood clearly demarcated. The wood is hard to very hard and heavy to very heavy; luster is moderate. Heartwood usually yellow-green fluorescent under UV light.

Additional comments

E. suavelons is not recorded on the IUCN Red list of threatened species.

Similar woods

Afzelia spp., *Albizia* spp., *Baphia nitida, Cylicodiscus gabunensis, Gilbertiodendron limba.*

Notes

Funtum



Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous, but apparent growth rings delimited by narrow areas of flattened fibers.
  Vessels: Vessels predominantly in radial multiples of 2–4; small diameter; medium abundance.
  Rays: Extremely narrow; numerous.
  Parenchyma: Apotracheal axial parenchyma diffuse-in-aggregate, sometimes difficult to resolve with a hand lens.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Heartwood whitish, heartwood and sapwood not demarcated. The wood is soft and light, and the luster is low.

Additional comments

F. elastica is recorded on the IUCN Red list of threatened species as a species of least concern.

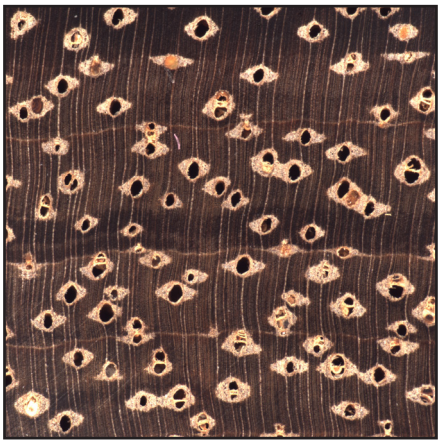
Similar woods

Difficult to discriminate from *Tetrorchidium didymostemon*.

Notes

Tetekon, Limabali, Vaa





Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous; apparent growth rings sometimes suggested by areas of fewer vessels and thicker-walled fibers.
  Vessels: Mostly solitary and in multiples of 2; medium to large diameter; few; commonly in echelon arrangement.
  Rays: Extremely narrow; numerous.
  Parenchyma: Paratracheal axial parenchyma wide vasicentric, lozenge aliform, and confluent connecting few vessels often in echelon. Marginal parenchyma sometimes present and faint.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood yellowish; heartwood dark brown; heartwood and sapwood distinctly demarcated. The wood is heavy and hard.

Additional comments

G. limba is recorded on the IUCN Red list of threatened species as a near threatened species.

Similar woods

Afzelia africana.

Notes

Gmelina

Anatomical Description of Wood

- **Transverse**
  Porosity: Faintly to distinctly semi-ring-porous with the earlywood distinguished more by the abundance than the size of the vessels.
  Vessels: Mostly solitary, some in radial multiples of 2–3, few in clusters; medium diameter; few to medium abundance; typically with abundant tyloses.
  Rays: Narrow to medium; average abundance to numerous.
  Parenchyma: Paratracheal axial parenchyma narrow vasicentric and sometimes confluent in connecting 2–3 vessels; marginal parenchyma typically present, varying from faint to wide and distinct.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood whitish to cream-colored; heartwood whitish to yellowish brown to reddish brown. The wood is light in weight, soft to hard, and strong.

Additional comments

G. arborea is not native to Ghana but is a plantation species.

Similar woods

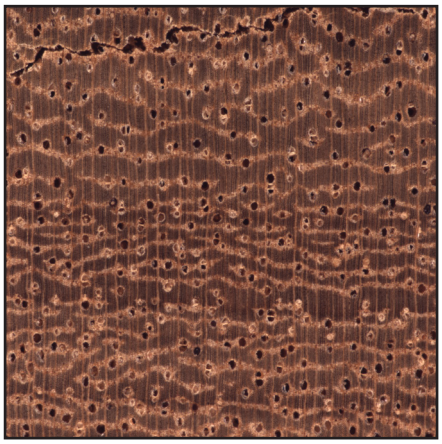
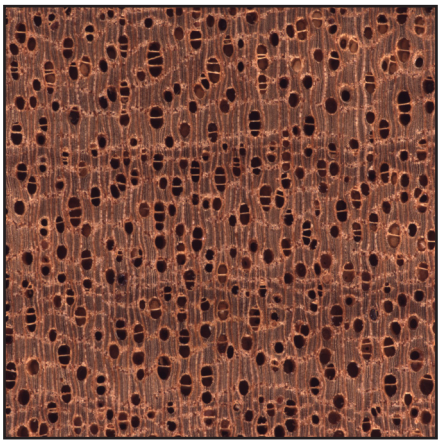
Copaifera salikounda, Entandrophragma spp.

Notes

Guarea cedrata
(Syn: *Leplaea cedrata*)

Meliaceae

Kwabohoro, Kwadwuma, Bossé

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous, but bands of thick-walled fibers suggestive of growth rings.
  Vessels: Solitary and some in radial multiples of 2–4; medium diameter; medium abundance.
  Rays: Narrow; average abundance to numerous.
  Parenchyma: Paratracheal axial parenchyma rarely lozenge aliform, commonly narrow confluent connecting many vessels intergrading with banded apotracheal parenchyma.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood pale color; heartwood pinkish brown to reddish brown; heartwood and sapwood clearly demarcated. The wood is medium weight and has a pleasant odor (cedar-like) when fresh.

Additional comments

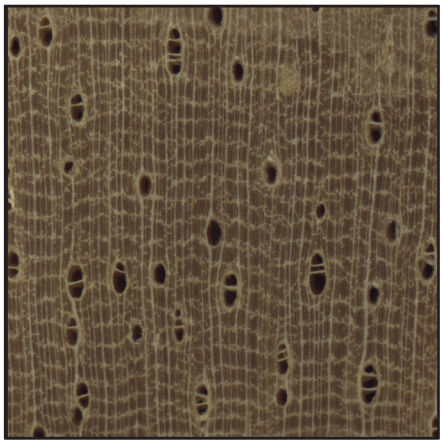
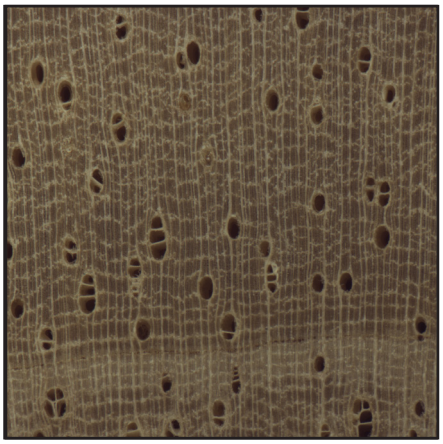
G. cedrata is recorded on the IUCN Red list of threatened species as a vulnerable species.

Similar woods

Cynometra ananta.

Notes

Rubberwood


Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Solitary and in radial multiples of 2–5; medium to large diameter; sparse to few; tyloses common in heartwood.
  Rays: Narrow; average abundance.
  Parenchyma: Apotracheal axial parenchyma in long narrow bands; marginal parenchyma present.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood not distinct from heartwood; heartwood light blonde to medium tan color, sometimes with medium brown streaks. Wood is light and has low luster.

Additional comments

H. brasiliensis is not native to Ghana but is a plantation species grown for natural rubber production.

Similar woods

Apocynaceae, such as *Alstonia boonei,* and other Euphorbiaceae.

Notes

Sese

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Occasionally solitary, mostly in radial multiples of 2–6 or more; small; moderately abundant.
  Rays: Narrow; numerous.
  Parenchyma: Absent to faint apotracheal axial parenchyma diffuse.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Wood soft and uniformly white, with no distinction between sapwood and heartwood.

Additional comments

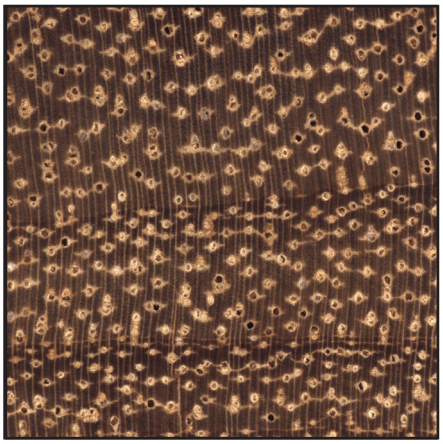
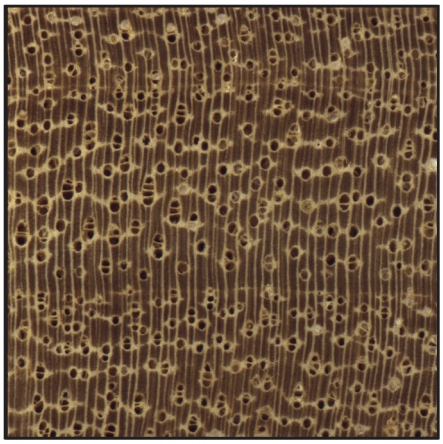
H. floribunda is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

Mitragyna stipulosa.

Notes

Nakwa, Anakwa, Kékélé

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Mostly solitary and in multiples of 2–3; small diameter; medium abundance; occasionally with white deposits in the heartwood.
  Rays: Narrow to medium width; average abundance.
  Parenchyma: Paratracheal axial parenchyma lozenge and winged aliform and/or narrow confluent connecting many vessels, but confluent bands are so narrow they do not clearly encompass the vessels; marginal parenchyma faint when present.
- **Tangential**
  Rays irregularly storied to well-storied, storying medium.
- **Other characters**
  Heartwood creamy white to light yellow; heartwood and sapwood not demarcated. The wood is light to moderately heavy, soft to moderately hard, and commonly of low luster.

Additional comments

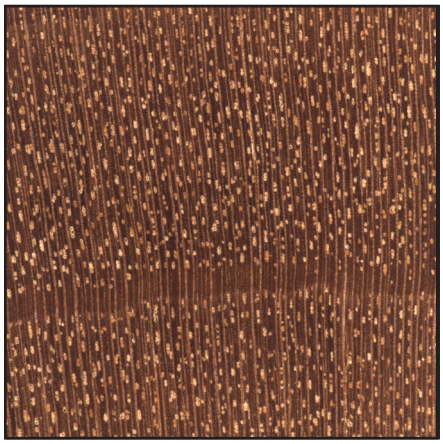
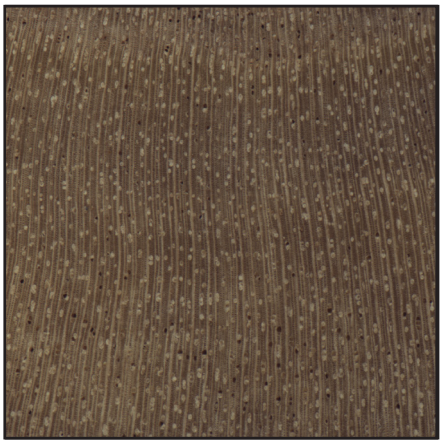
H. grandis is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

Extremely similar to *Celtis*.

Notes

Atibidua


Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Mostly solitary and in radial multiples of 2–3; very small to small diameter; abundant.
  Rays: Narrow; numerous.
  Parenchyma: Axial parenchyma absent or extremely rare.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  The wood is light brown or pink, darkening to orange.

Additional comments

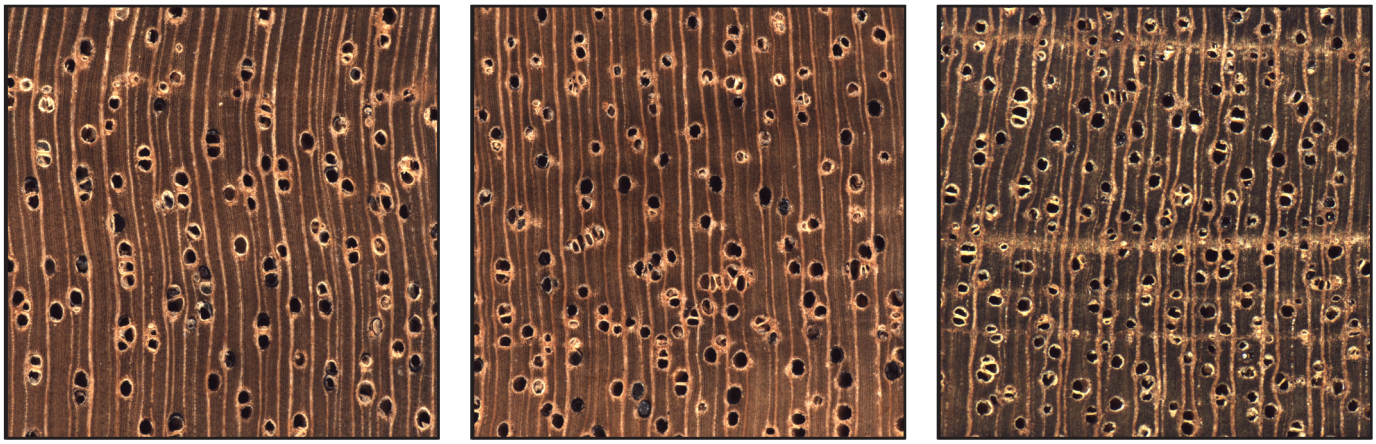
H. acida is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

Voacanga africana.

Notes

Krumben, Dubini, Kuntunkuri, African Mahogany, Acajou



Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Mostly solitary and in multiples of 2–3; medium to medium-large diameter; medium abundance; brown-colored deposits common in heartwood vessels.
  Rays: Medium width; average abundance.
  Parenchyma: Marginal parenchyma mostly absent to faint to common and distinct.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood yellowish white to pale brown, 3–8 cm wide; heartwood pinkish brown to deep red with a copper reflection (with a purple tint in *K. senegalensis*); heartwood and sapwood demarcated. The wood is light to moderately heavy, soft to moderately hard, and lustrous; it can have an attractive figure with irregular ripple marks.

Additional comments

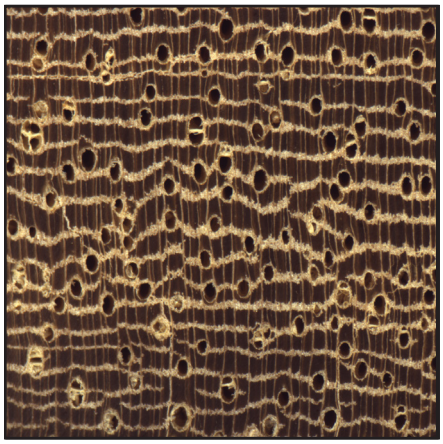
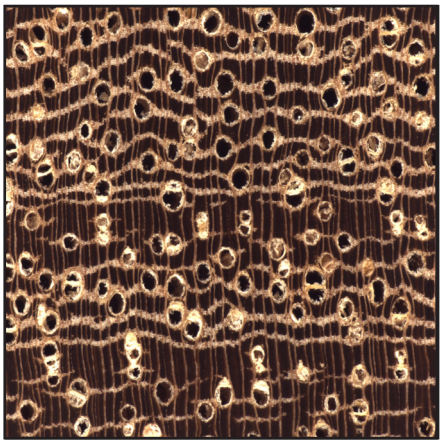
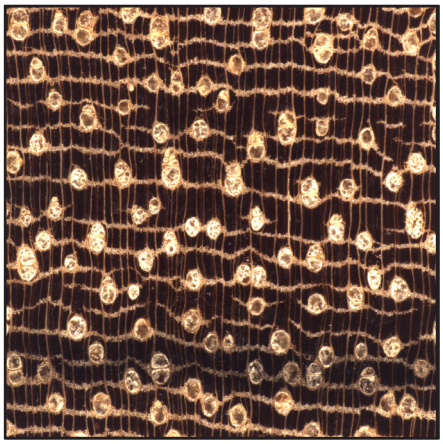
All three species are recorded on the IUCN Red list of threatened species as vulnerable.

Similar woods

Carapa procera.

Notes

Kroma, Eveuss

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous; apparent growth rings sometimes suggested by areas of fewer vessels and thicker-walled fibers.
  Vessels: Mostly solitary and in multiples of 2; medium-large diameter; medium abundance; tyloses in the heartwood, but most vessels without tyloses.
  Rays: Narrow; average abundance.
  Parenchyma: Paratracheal axial parenchyma winged aliform to narrow confluent connecting many vessels, sometimes only on side of the vessel; confluent bands intergrade with narrow long banded apotracheal axial parenchyma.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood light brown, thin; heartwood orange-yellow to golden brown with wide dark veining and often with zigzag markings; heartwood and sapwood not clearly demarcated. The wood is very heavy, very hard, elastic, and low in luster.

Additional comments

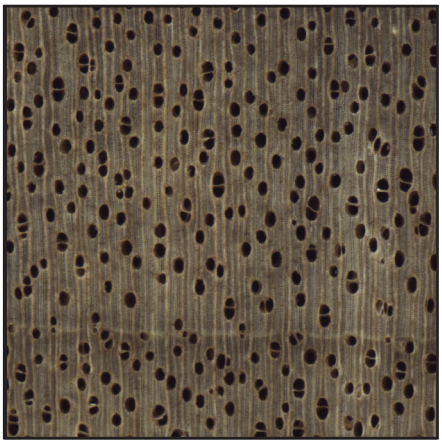
K. gabonensis is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

Lophira alata, Milicia spp.

Notes

Kumanini, Kumbi



Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous; apparent growth rings delimited by thicker-walled fibers.
  Vessels: Mostly solitary and in multiples of 2–3, in faint echelon; medium diameter; few to medium abundance.
  Rays: Narrow; average abundance.
  Parenchyma: Essentially absent.
- **Tangential**
  Rays nonstoried but with prominent radial canals.
- **Other characters**
  Heartwood creamy white to pale brown or pinkish grey; heartwood and sapwood indistinctly demarcated. The wood is light in weight, is low in luster, and has a resinous odor.

Additional comments

L. welwitschii is not recorded on the IUCN Red list of threatened species.

Similar woods

Margaritaria discoidea.

Notes

Sante, Oto Oto, Papea

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous; apparent growth rings sometimes suggested by areas of fewer vessels and thicker-walled fibers.
  Vessels: Solitary and radial multiples usually of 2–3, sometimes in radial chains of many narrower vessels and in small clusters; medium diameter; few to medium abundance.
  Rays: Narrow; numerous.
  Parenchyma: Paratracheal axial parenchyma lozenge aliform to mostly long, wide confluent connecting many vessels. Marginal parenchyma narrow but commonly present.
- **Tangential**
  Rays storied, storying fine to medium.
- **Other characters**
  Sapwood cream to pale brown; heartwood yellowish brown; heartwood and sapwood distinctly demarcated. The wood is moderately heavy, hard, and low luster. Heartwood usually yellow-green fluorescence under UV light.

Additional comments

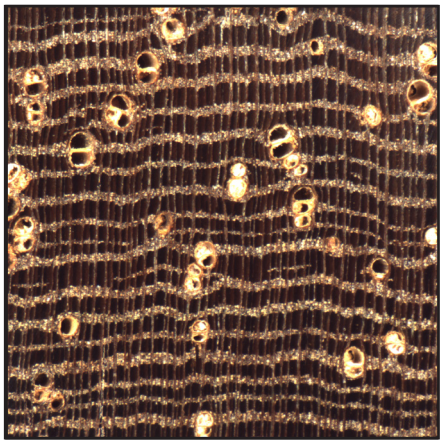
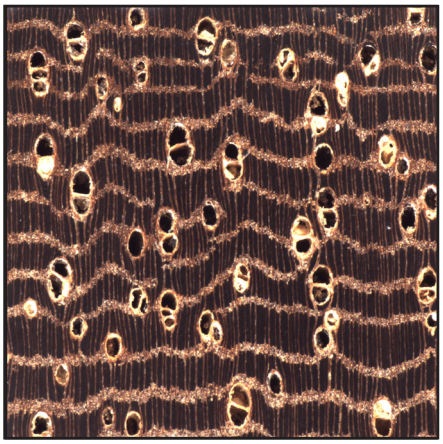
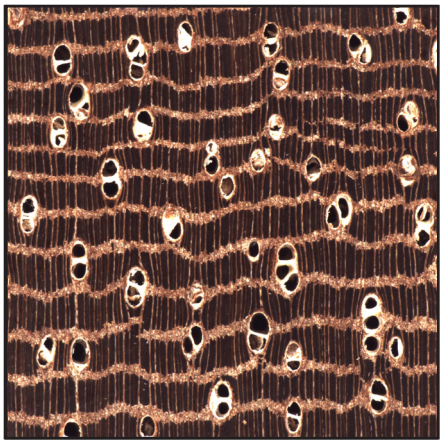
L. sericeus is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

Amphimas pterocarpoides.

Notes

Kaku, Ekki, Azobé

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Solitary and in radial multiples of 2–3; medium to large diameter; few; sometimes in short echelon or distinct radial arrangement; commonly with white deposits in heartwood vessels.
  Rays: Narrow; numerous.
  Parenchyma: Apotracheal axial parenchyma in long wide bands; bands commonly interrupted by vessels, but vessels are not surrounded by parenchyma.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood pale pink; heartwood dark red to purple-brown; heartwood and sapwood clearly demarcated. The wood is very hard, heavy, and very durable.

Additional comments

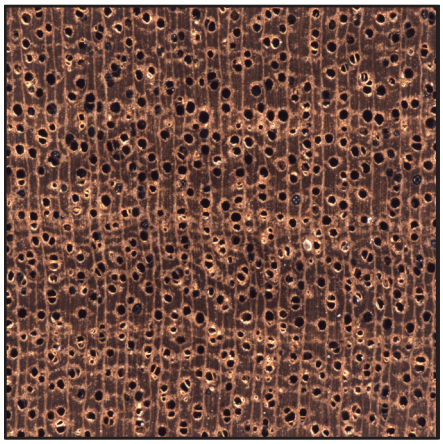
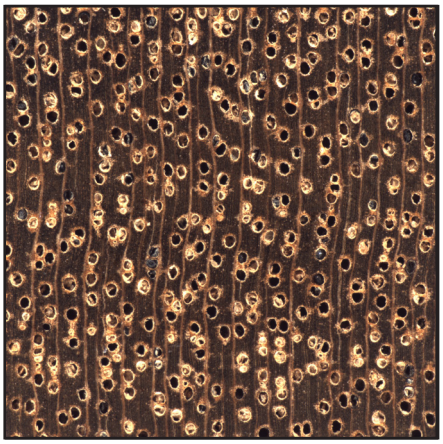
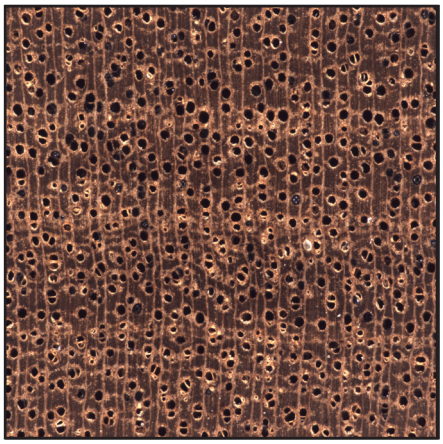
L. alata is recorded on the IUCN Red list of threatened species as a vulnerable species.

Similar woods

Parinari excelsa.

Notes

Mpengwa, Dubinibiri, Dibétou

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous; apparent growth rings sometimes suggested by areas of fewer vessels and thicker-walled fibers.
  Vessels: Mostly solitary, some in radial multiples of 2–3; sometimes in faint echelon arrangement; small to medium diameter; abundant; with black-colored deposits (gums) sometimes present in heartwood vessels.
  Rays: Narrow; average abundance.
  Parenchyma: Paratracheal axial parenchyma narrow vasicentric and narrow alifrom, sometimes just covering one side of the vessel; apotracheal axial parenchyma diffuse in aggregate common in spaces between rays where no vessels are present.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood light grey; heartwood grey-yellow, grey-brown to dark brown; heartwood and sapwood clearly demarcated.

Additional comments

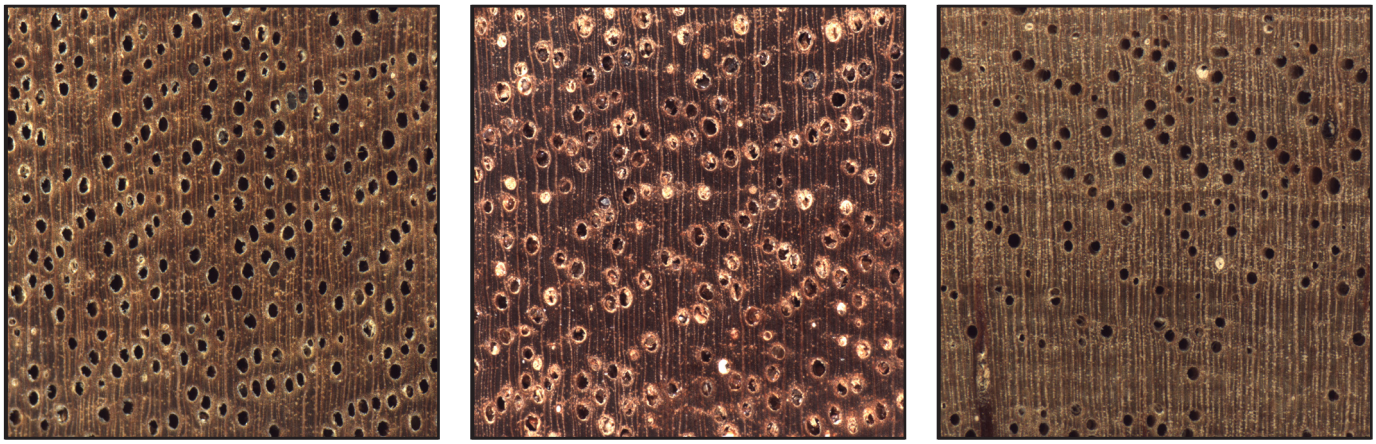
L. trichilioides is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

Entandrophragma spp.

Notes

Bompagya, Oboto



Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous to faintly semi-ring-porous; apparent growth rings sometimes suggested by areas of fewer vessels and thicker-walled fibers.
  Vessels: Exclusively solitary (over 90%); commonly in echelon arrangement; medium to large diameter; medium abundance; commonly with tyloses or deposits.
  Rays: Narrow; numerous.
  Parenchyma: Apotracheal axial parenchyma diffuse and/or diffuse-in-aggregate; paratracheal axial parenchyma wide vasicentric grading to confluent, but in contrast with the apotracheal parenchyma, this paratracheal parenchyma is faint and not clearly distinct from the adjacent fibers.
- **Tangential**
  Rays nonstoried; large and obvious radial canals present.
- **Other characters**
  Sapwood pinkish brown to pale brown and up to 6 cm wide; heartwood reddish brown to purplish brown; heartwood and sapwood distinctly demarcated. The wood is resinous, and dark oily spots are often present on tangential surfaces. The wood is moderately hard and heavy. Radial canals, only, are conspicuously yellow-green fluorescent under UV light.

Additional comments

M. africana is not recorded on the IUCN Red list of threatened species.

Similar woods

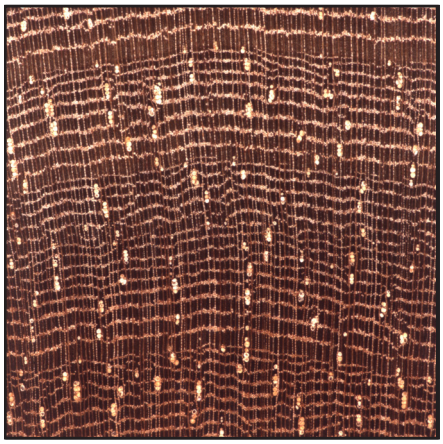
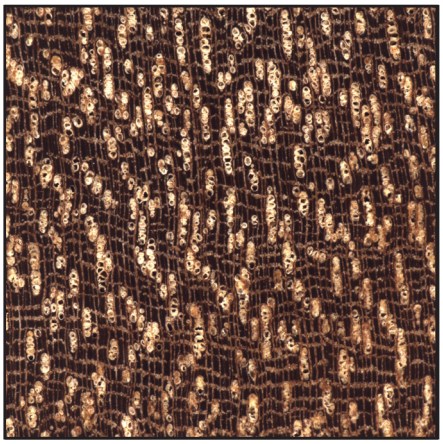
Nauclea diderrichii; *Tectona grandis* shows similar semi-ring-porosity.

Notes

Manilkara obovata Sapotaceae

(Syn: *M. cuneifolia*; *M. lacera*; *M. multinervis*; *Chrysophyllum obovatum*; *Mimusops multinervis*)

Berekankum, Monghinza


Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous; apparent growth rings sometimes suggested by areas of fewer vessels and thicker-walled fibers.
  Vessels: Predominantly in radial multiples of 4 or more; small diameter; abundant; commonly with tyloses in the heartwood.
  Rays: Narrow; numerous.
  Parenchyma: Apotracheal axial parenchyma diffuse-in-aggregate, intergrading with long, irregular, narrow banded.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood yellowish to pale brown; heartwood brown to reddish brown, heartwood and sapwood clearly demarcated. The wood is hard and low in luster.

Additional comments

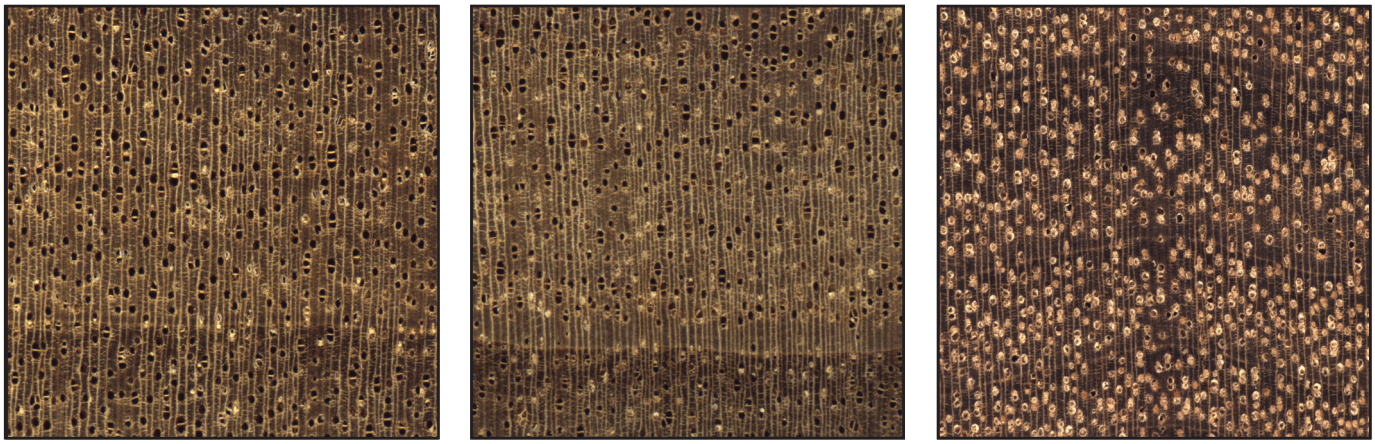
M. obovata is not recorded on the IUCN Red list of threatened species.

Similar woods

Other Sapotaceae, such as *Chrysophyllum*, *Pouteria, Tieghemella* spp.

Notes

Oprono, Beté



Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Solitary and in radial multiples of 2–3; small to medium diameter; abundant; tyloses common in heartwood.
  Rays: Narrow; numerous.
  Parenchyma: Apotracheal axial parenchyma diffuse-in-aggregate, sometimes coalescing to narrow banded; faint marginal parenchyma sometimes present.
- **Tangential**
  Rays well-storied, storying medium.
- **Other characters**
  Sapwood white to pinkish; heartwood yellowish brown to dark grey-brown, often with purple and reddish or greyish green streaks in alternating light and dark bands; heartwood and sapwood distinctly demarcated. The wood is of medium weight, moderately hard, and moderate luster.

Additional comments

M. altissima is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

Nesogordonia papaverifera.

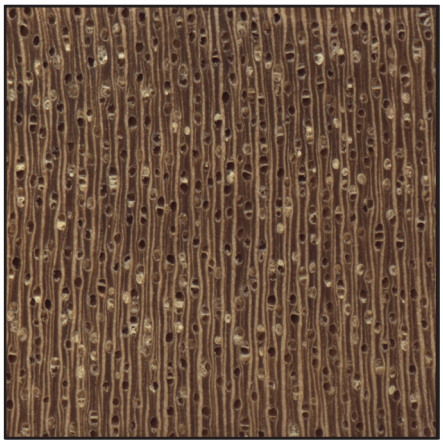
Notes

Margaritaria discoidea
(Syn: *Phyllanthus discoideus*)

Phyllanthaceae (Euphorbiaceae)

Pepea





Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Solitary and in radial multiples of 2–3; small to medium diameter; medium abundance; tyloses common.
  Rays: Mostly narrow to medium width; average abundance.
  Parenchyma: Axial parenchyma essentially absent.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood yellowish; heartwood pinkish white to brownish red. The wood is hard and heavy.

Additional comments

M. discoidea is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

Hymenocardia acida, Lannea welwitschii, Voacanga africana.

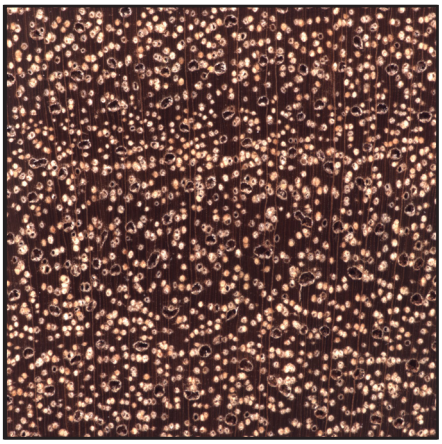
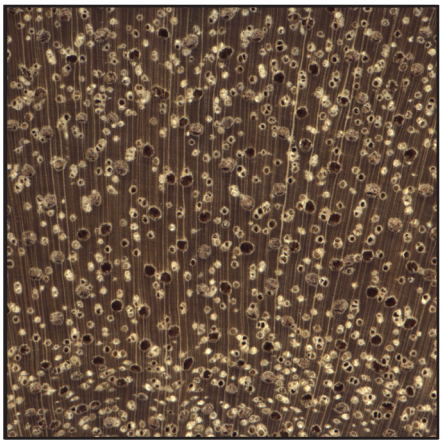
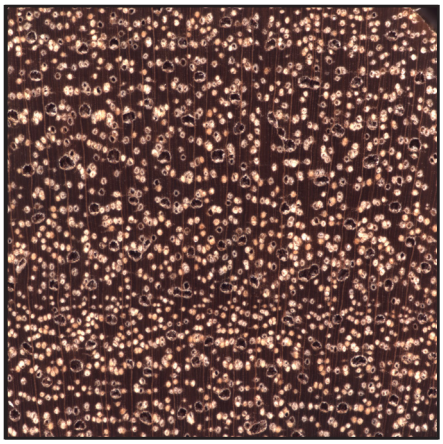
Notes

Memecylon lateriflorum

Melastomataceae

(Syn: *Memecylon applanatum*; *M. donianum*; *M. simii*)

Otwese, Twetweakuo

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous; apparent growth rings sometimes suggested by areas of fewer vessels and thicker-walled fibers.
  Vessels: Exclusively solitary, sometimes in short echelon arrangement; small diameter; abundant; irregularly shaped larger structures appearing somewhat like vessels with resinous or gummy contents common.
  Rays: Narrow; average abundance.
  Parenchyma: Paratracheal axial faintly vasicentric or absent.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Heartwood yellow-brown to dark brown. The wood is very dense and heavy.

Additional comments

M. lateriflorum is not recorded on the IUCN Red list of threatened species.

Similar woods

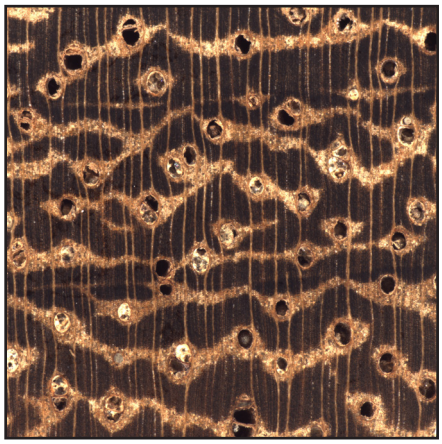
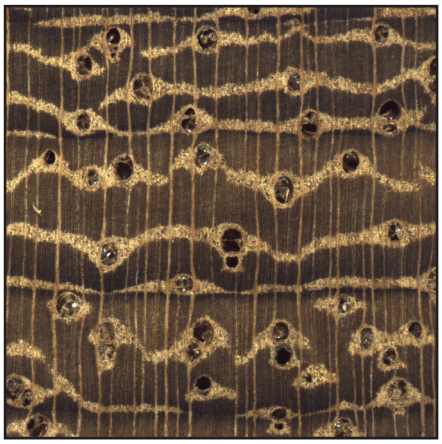
Lannea welwitschii, Margaritaria discoidea.

Notes

Milicia spp. *M. excelsa; M. regia*
(Syn: *Chlorophora excelsa; C. regia*)

Moraceae

Odum, Odum-nua, Iroko


Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Solitary and in radial multiples of 2–3; large diameter; sparse; tyloses abundant in the heartwood.
  Rays: Narrow to medium width; average abundance.
  Parenchyma: Paratracheal axial parenchyma lozenge aliform and predominantly confluent connecting few to many vessels; marginal parenchyma present in faint lines.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood yellowish white; heartwood yellowish brown to chocolate brown; heartwood and sapwood clearly demarcated. The wood is of medium weight, moderately hard, somewhat greasy, and low luster.

Additional comments

M. excelsa is recorded on the IUCN Red list of threatened species as a near threatened species, and *M. regia* is listed as vulnerable.

Similar woods

Amphimas pterocarpoides, Morinda lucida, *Morus mesozygia*.

Notes

Mitragyna stipulosa

Rubiaceae

(Syn: *Fleroya stipulosa; Hallea stipulosa*)

Subaha, Abura/Bahia

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous to faintly semi-ring-porous; the earlywood, if present, is distinguished by tangentially aligned slightly larger vessels.
  Vessels: Solitary but mostly in radial multiples of 2–6 or more; medium diameter; abundant.
  Rays: Narrow; numerous.
  Parenchyma: Apotracheal axial parenchyma diffuse-in-aggregate; faint apparent marginal parenchyma, when present, composed of tangentially aligned discontinuous diffuse-in-aggregate parenchyma.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Heartwood light brown; heartwood and sapwood not demarcated. The wood is light in weight and soft.

Additional comments

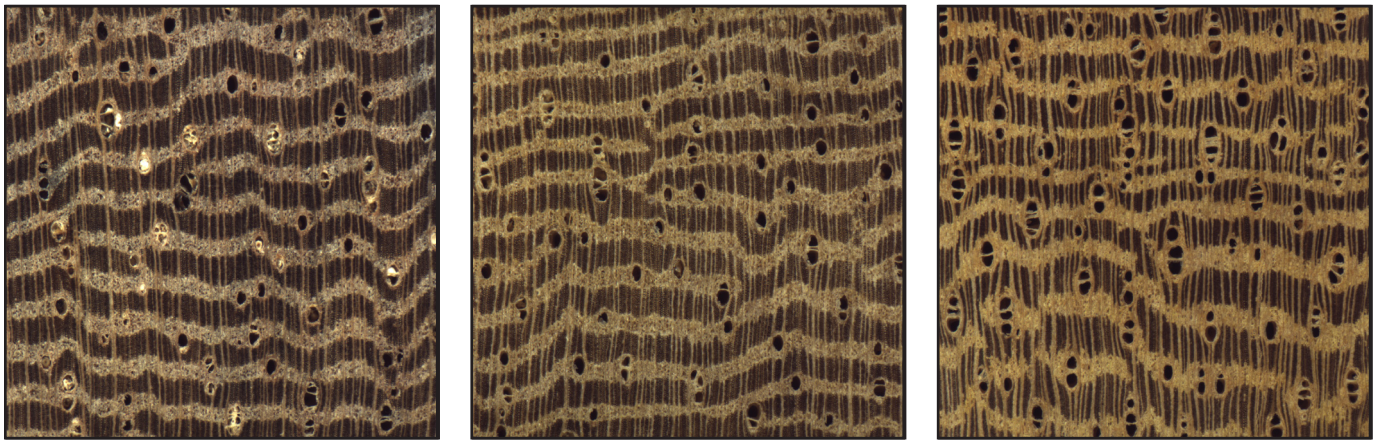
M. stipulosa is recorded on the IUCN Red list of threatened species as a vulnerable species.

Similar woods

In many ways similar to Sapotaceae and/or Apocynaceae, such as *Holarrhena* spp.

Notes

Konkroma



Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Solitary and in radial multiples of 2–6; medium to large diameter; few; white deposits in heartwood common.
  Rays: Narrow; numerous.
  Parenchyma: Paratracheal axial parenchyma wide confluent connecting many vessels, in regular alternation with fibers.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  The fresh wood is yellow, darkening to yellow-brown in the sapwood and dark brown in the heartwood. The wood is medium weight and hard.

Additional comments

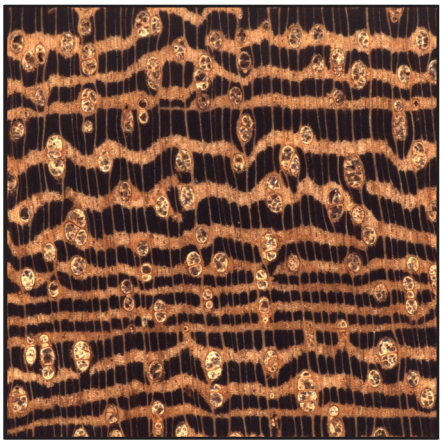
M. lucida is also known as "Ngononkyene", which in some regions of Ghana refers to *Cleistopholis patens*. *M. lucida* is not recorded on the IUCN Red list of threatened species.

Similar woods

Milicia spp., similar yellowish color and confluent parenchyma, but *Morinda lucida* has smaller vessels without tyloses and more abundant and longer radial multilpes; *Morus mesozygia, Amphimas pterocarpoides*.

Notes

Wonton, Difou


Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Solitary and in radial multiples of 2–3; small to large diameter; sparse to few; tyloses abundant in heartwood.
  Rays: Narrow; medium abundance to numerous.
  Parenchyma: Paratracheal axial parenchyma narrow winged-aliform with the narrowest vessels, predominantly narrow confluent connecting many vessels; marginal parenchyma present and narrower than the confluent parenchyma.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood white to grey; heartwood yellowish when freshly cut, darkening to brown on exposure; heartwood and sapwood distinctly demarcated. The wood is moderately heavy to heavy, strong, and hard to very hard and has moderate luster.

Additional comments

M. mesozygia is not recorded on the IUCN Red list of threatened species.

Similar woods

Milicia spp., *Morinda lucida*.

Notes

Kusia, Bilinga, Opepe

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Exclusively solitary; medium to large diameter; few to medium abundance; commonly in echelon arrangement.
  Rays: Narrow; numerous.
  Parenchyma: Apotracheal axial parenchyma diffuse to faintly diffuse-in-aggregate.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood whitish to pale yellow; heartwood golden yellow, often with an orangish cast; heartwood and sapwood clearly demarcated. Heartwood usually yellow-green fluorescent under UV light.

Additional comments

N. diderrichii is recorded on the IUCN Red list of threatened species as a vulnerable species.

Similar woods

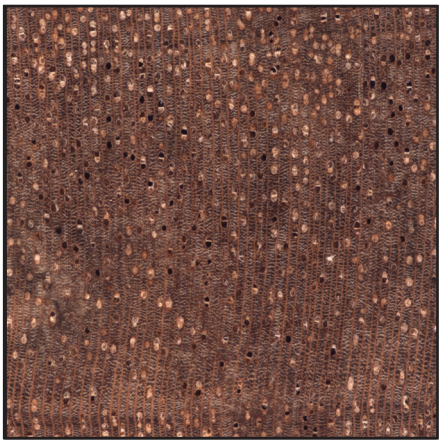
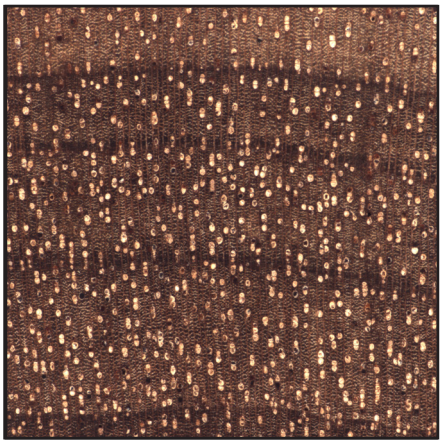
Mammea africana.

Notes

Nesogordonia papaverifera
(Syn: *Cistanthera papaverifera*)

Malvaceae

Danta, Epro, Akumaba, Abumana, Kotibé


Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous; apparent growth rings sometimes suggested by areas of fewer vessels and thicker-walled fibers.
  Vessels: Some solitary, mostly in radial multiples of 2–6; small diameter; relatively abundant; radial multiples sometimes also in radial arrangement.
  Rays: Narrow; numerous; can be difficult to resolve with hand lens.
  Parenchyma: Apotracheal axial parenchyma diffuse-in-aggregate.
- **Tangential**
  Rays well-storied, storying medium.
- **Other characters**
  Sapwood pale; heartwood reddish brown; heartwood and sapwood sharply demarcated. The wood is hard and of medium density.

Additional comments

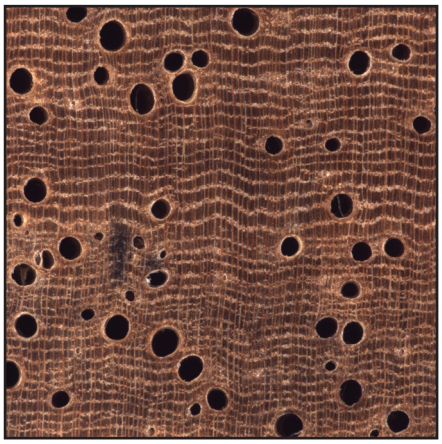
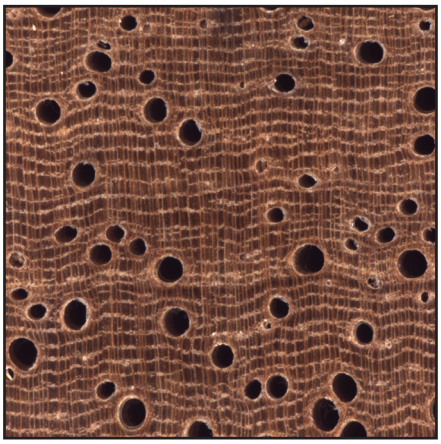
N. papaverifera is recorded on the IUCN Red list of threatened species as a vulnerable species.

Similar woods

Mansonia altissima.

Notes

Afam, Sougué

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Exclusively solitary; some in echelon arrangement; two classes, small and quite large diameter; sparse to few; largest vessels sometimes with tyloses in heartwood.
  Rays: Narrow; numerous.
  Parenchyma: Apotracheal axial parenchyma narrow, long, and regularly banded, sometimes with diffuse-in-aggregate between the bands. Smaller vessels sometimes with aliform paratracheal parenchyma.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood creamy white; heartwood pale reddish, chocolate brown, or greenish grey; heartwood and sapwood not clearly demarcated. The wood is hard, heavy, very strong, and tough, and luster is low.

Additional comments

P. excelsa is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

Some species of *Entandrophragma*.

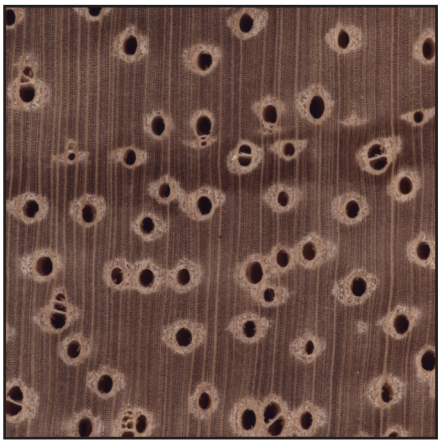
Notes

Parkia spp. *P. bicolor*; *P. biglobosa*

(Syn: *P. clappertoniana*)

Leguminosae (Fabaceae)

Asoma, Essang


Anatomical Description of Wood

- **Transverse**

  Porosity: Diffuse-porous.

  Vessels: Mostly solitary, sometimes in radial multiples or clusters of 2–3; medium to large diameter; sparse to few; gums and dark deposits in heartwood.

  Rays: Narrow to medium width; few to average abundance.

  Parenchyma: Paratracheal axial parenchyma mostly lozenge aliform to confluent connecting few to many vessels; some lozenge aliform with extremely long, triangular wings; narrow marginal parenchyma typically present.
- **Tangential**

  Rays nonstoried to sometimes irregularly storied.
- **Other characters**

  Heartwood pale yellow, sometimes with darker irregular streaks; heartwood indistinctly demarcated from the wide sapwood. The wood is moderately hard, light, of medium density, and low in luster. Heartwood usually with yellow-green fluorescent streaks under UV light.

Additional comments

Both species are recorded on the IUCN Red list of threatened species as species of least concern.

Similar woods

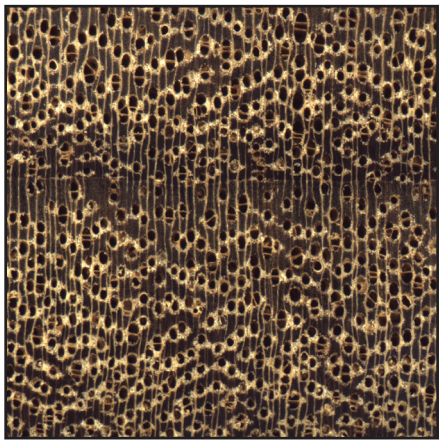
Afzelia africana, *Albizia* spp., *Cylicodiscus gabunensis*, *Erythrophleum suaveolens*, *Gilbertiodendron limba*.

Notes

Pericopsis elata
(Syn: *Afrormosia elata*)

Leguminosae (Fabaceae)

Kokrodua, Afrormosia, Asamela



Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous; apparent growth rings sometimes suggested by areas of fewer vessels and thicker-walled fibers.
  Vessels: Solitary and arranged in radial multiples of 2–3; small diameter; medium to abundant; gums and other deposits in heartwood often present.
  Rays: Narrow; medium abundance.
  Parenchyma: Paratracheal axial parenchyma narrow winged to lozenge aliform, commonly narrow, irregular confluent connecting many vessel, often only on one side of the vessels; narrow marginal parenchyma common.
- **Tangential**
  Rays well-storied, storying medium.
- **Other characters**
  Sapwood pale yellow-brown; heartwood yellowish brown to greenish brown with darker streaks, turning dark brown upon exposure; heartwood and sapwood clearly demarcated. The wood is moderately heavy and hard, and luster is usually low.

Additional comments

Protected by CITES (Appendix II). *P. elata* is recorded on the IUCN Red list of threatened species as an endangered species.

Similar woods

Erythrophleum suaveolens.

Notes

Slash Pine, Longleaf Pine, Radiata Pine, Loblolly Pine, Caribbean Pine

Anatomical Description of Wood

- **Transverse**
  Growth rings distinct, transition abrupt; latewood half the width of the growth ring in slow-grown material, often less than one-quarter of the growth ring in wider rings. Resin canals present and easily seen with a hand lens.
- **Tangential**
  Radial resin canals sometimes visible, but otherwise no useful characters on this surface.
- **Other characters**
  As a softwood, *Pinus* lack vessels.

Additional comments

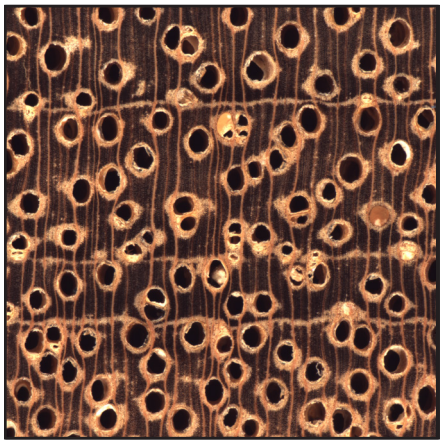
As of this writing, only the yellow pines are being imported to Ghana, predominantly as utility/transmission poles. *Pinus caribaea* can be found in plantations in CSIR-FORIG experimental plots. *Pinus*, or any other softwood, in any form other than a utility pole should be submitted for laboratory identification.

Notes

Piptadeniastrum africanum
(Syn: *Piptadenia africana*)

Leguminosae

Dahoma, Odan, Elae, Dabema



Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Mostly solitary and in radial multiples of 2–3; medium diameter; relatively few; often with gums and other deposits in heartwood vessels. Small vessels sometimes associated with marginal parenchyma.
  Rays: Medium; average abundance.
  Parenchyma: Paratracheal axial parenchyma mostly vasicentric to lozenge aliform, sometimes confluent connecting few vessels; narrow marginal parenchyma present.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood light color; heartwood light brown to yellow-brown; heartwood and sapwood clearly demarcated. The wood has an unpleasant odor (ammoniacal). Heartwood conspicuously yellow-green fluorescent under UV light.

Additional comments

P. africanum is not recorded on the IUCN Red list of threatened species.

Similar woods

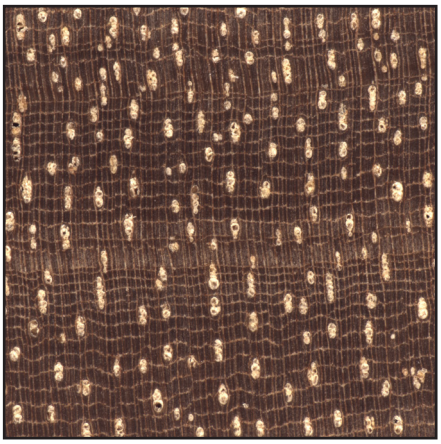
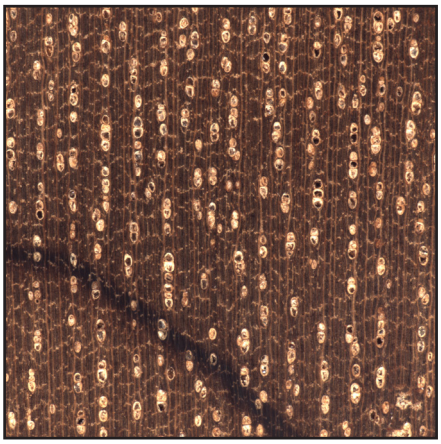
Berlinia grandiflora.

Notes

Pouteria altissima
(Syn: *Aningeria altissima*)

Sapotaceae

Asanfena, Asamfona, Aningré


Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Predominantly in radial multiples of 4–8 or more; small diameter; medium abundance.
  Rays: Narrow; numerous.
  Parenchyma: Apotracheal axial parenchyma narrow banded, typically wavy.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Heartwood creamy white to reddish brown; indistinctly demarcated from the 3–6 cm wide band of sapwood.

Additional comments

Pouteria altissima often appears to have evident growth rings due to difference in fiber wall thickness, and the growth ring outline is often wavy or irregular. *P. altissima* is not recorded on the IUCN Red list of threatened species.

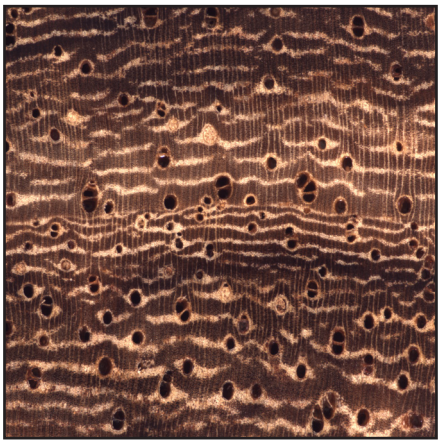
Similar woods

Other Sapotaceae, such as *Chrysophyllum*, *Manilkara, Tieghemella* spp.

Notes

African Rosewood, Krayie, Ven





Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous to faintly semi-ring-porous.
  Vessels: Mostly solitary, some radial multiples of 2–3 and clusters; mostly large diameter with some much smaller vessels; relatively few; gums and dark resinous contents common, sometimes with numerous tiny tyloses.
  Rays: Narrow; numerous.
  Parenchyma: Paratracheal axial parenchyma vasicentric to winged aliform and long, narrow confluent connecting few to many vessels; apotracheal axial parenchyma diffuse-in-aggregate sometimes coalescing into narrow wavy apotracheal banded; faint and narrow marginal parenchyma common.
- **Tangential**
  Rays well-storied, storying fine.
- **Other characters**
  Sapwood yellowish or pale cream-colored; heartwood yellowish brown to reddish brown, often with purplish brown streaks, heartwood and sapwood distinctly demarcated. The wood is moderately heavy and hard; fresh wood has an unpleasant aroma. Heartwood usually with faint yellow-green fluorescence under UV light.

Additional comments

Pterocarpus erinaceus is protected by CITES (Appendix II) and recorded on the IUCN Red list of threatened species as endangered. In addition, on March 12, 2019, the government of Ghana imposed a ban on harvesting, transporting, and exporting *Pterocarpus* spp.

Similar woods

Baphia nitida, Distemonanthus benthamianus, Pericopsis elata.

Notes

Otie, Ilomba

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Solitary and in radial multiples of 2–4; medium to large diameter; sparse to few, sometimes with tyloses.
  Rays: Medium width; average abundance.
  Parenchyma: Essentially absent.
- **Tangential**
  Rays nonstoried. Radial laticifers appearing as small radial canals and visible as minute brown dots wihin the rays.
- **Other characters**
  Heartwood greyish white to pinkish brown; heartwood and sapwood not clearly differentiated. The wood is very light to light in weight, is very soft to soft, and has no luster; when fresh, it has an unpleasant odor which disappears upon drying.

Additional comments

P. angolensis is not recorded on the IUCN Red list of threatened species.

Similar woods

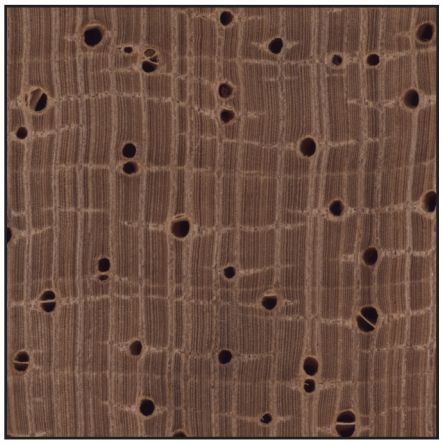
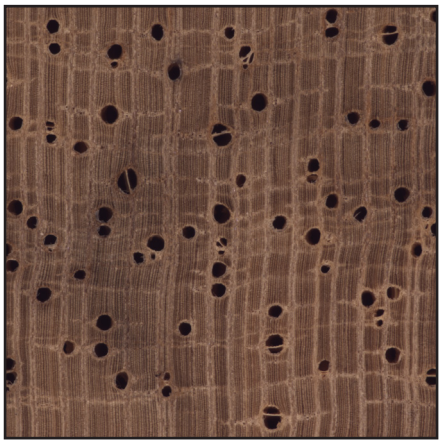
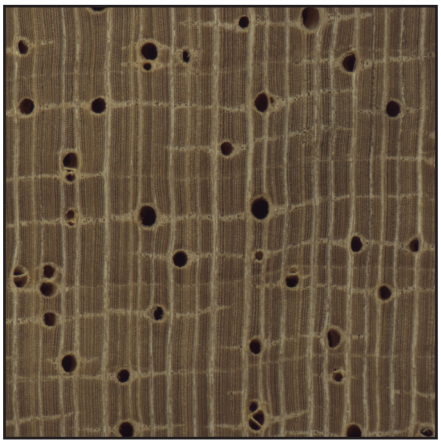
Most Anacardiaceae, especially *Antrocaryon micraster*.

Notes

Quassia gabonensis
(Syn: *Q. silvestris*; *Hannoa klaineana*)

Simaroubaceae

Fotie, Hotrohotro, Hannoa, Effeu

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Mostly solitary and some in radial multiples of 2–3; medium diameter; few.
  Rays: Medium to medium-wide; average abundance.
  Parenchyma: Paratracheal axial parenchyma rarely narrow winged aliform, mostly narrow confluent connecting many vessels, intergrading with long, narrow apotracheal bands; faint, irregular marginal parenchyma sometimes present.
- **Tangential**
  Rays irregularly storied to nonstoried.
- **Other characters**
  Heartwood whitish to pale yellow; heartwood and sapwood not demarcated. The wood is lightweight, soft, and lustrous.

Additional comments

Q. gabonensis is not recorded on the IUCN Red list of threatened species.

Similar woods

Anthocleista nobilis, Cleistopholis patens, Parinari excelsa.

Notes

Wama, Essessang

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Solitary and in radial multiples of 2–8; often with vessel diameter decreasing within the vessel multiple; large diameter; sparse; tyloses often present.
  Rays: Narrow to medium width; numerous.
  Parenchyma: Apotracheal axial parenchyma diffuse and/or diffuse in aggregates, not always visible with a hand lens.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Heartwood whitish to pale yellow; heartwood and sapwood not clearly demarcated. The wood is very light in weight, very soft, and brittle.

Additional comments

R. heudelotii var. *tomentellum* is recorded on the IUCN Red list of threatened species as vulnerable.

Similar woods

Difficult to discriminate from *Discoglypremna caloneura*.

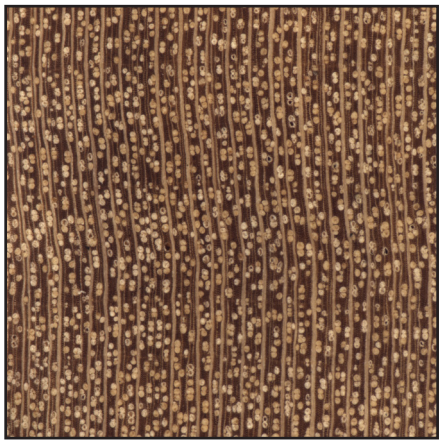
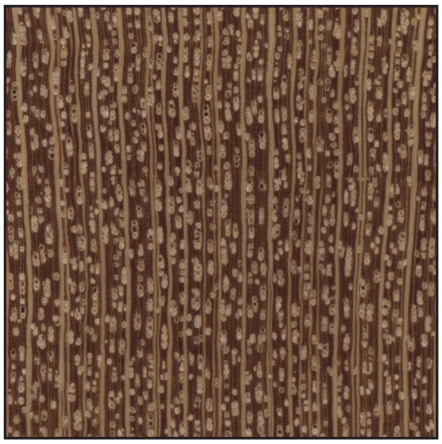
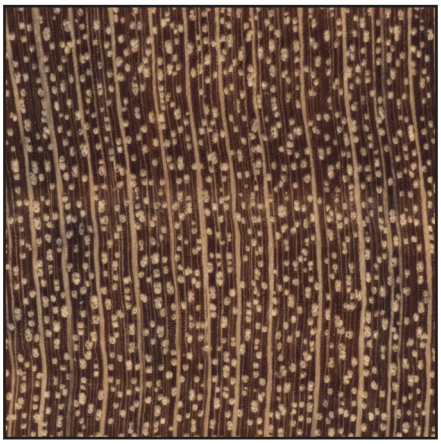
Notes

Scottellia klaineana

Achariaceae (Flacourtiaceae)

(Syn: *S. chevalieri; S. coriacea*)

Tiabutuo, Kruku, Akossika

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Solitary in radial multiples of 2–3; small to medium diameter; abundant.
  Rays: Of two widths, fairly wide and narrow; average abundance.
  Parenchyma: Axial parenchyma absent or extremely rare, when present, diffuse to diffuse-in-aggregate, not always visible with a lens.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Heartwood a light yellow, sometimes with the presence of grey or dark veins; heartwood and sapwood not demarcated. The wood is light to moderately heavy; soft to moderately hard, and of moderate luster.

Additional comments

S. klaineana is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

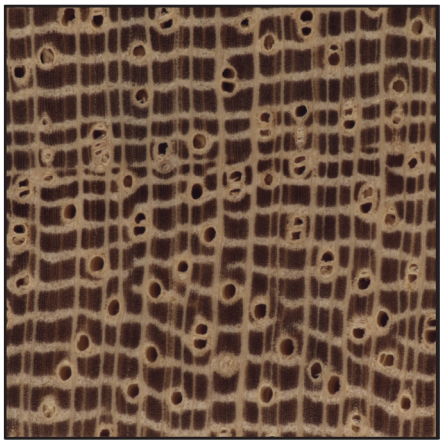
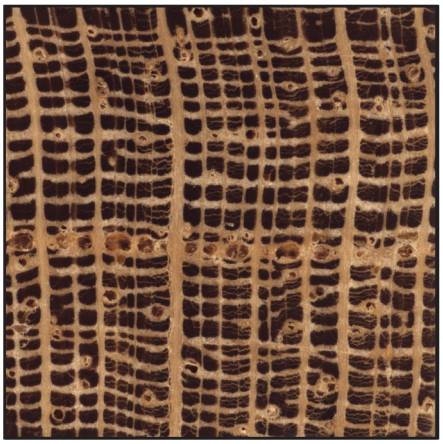
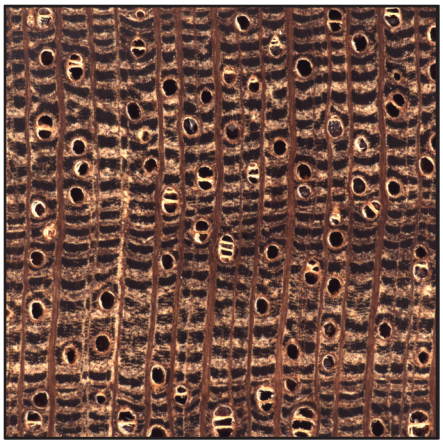
Vernonia conferta.

Notes

Sterculia spp. *S. oblonga; S. rhinopetala; S. tragacantha* Malvaceae

S. oblonga (Syn: *Eribroma oblonga)*

Ohaa, Wawabima, Sofo

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Solitary and in radial multiples and/or clusters of 2–4; medium to large diameter; sparse; some with brown-colored deposits in heartwood.
  Rays: Of two distinct sizes, medium width and wide; few to average abundance.
  Parenchyma: Apotracheal axial parenchyma in bands wider than the fiber bands, most vessels are at least partly embedded in apotracheal bands, and therefore can appear very similar to paratracheal confluent parenchyma; marginal parenchyma present.
- **Tangential**
  Rays nonstoried, but axial elements are storied, sometimes showing faintly with a hand lens.
- **Other characters**
  In *E. oblonga* and *S. tragacantha*, heartwood a creamy white to pale yellowish brown; heartwood not clearly demarcated from the white sapwood. The wood is moderately hard, moderately heavy, and usually high in luster; green wood usually has an unpleasant odor that disappears.
  In *S. rhinopetala*, sapwood cream; heartwood pale to deep reddish brown; heartwood and sapwood distinctly demarcated. The wood is moderately heavy to heavy, tough, and moderately hard to hard.

Additional comments

Tangential bands of large traumatic canals not uncommon. *S. oblonga* is recorded on the IUCN Red list of threatened species as vulnerable, *S. rhinopetala* is not listed, and *S. tragacanth*a is listed as a species of least concern.

Similar woods

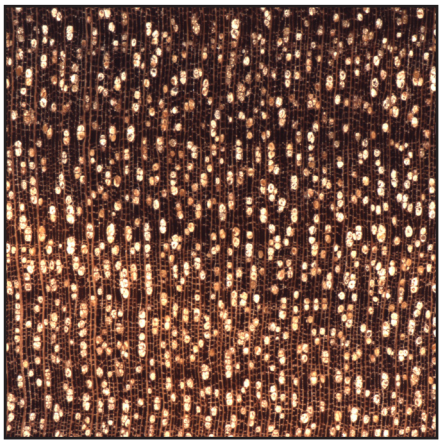
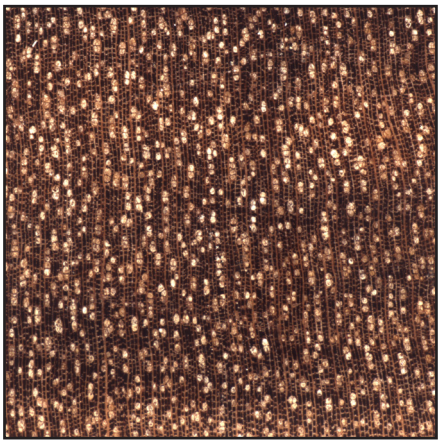
Cleistopholis patens, *Cola gigantea*, *Duguetia staudtii*.

Notes

Strombosia pustulata var. *pustulata*
(Syn: *S. glaucescens*)

Strombosiaceae (Olacaceae)

Afena, Mukundu

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Predominantly in radial multiples of 2–4, often also in radial arrangement; small diameter; medium abundance; tyloses common but sometimes not easily visible with hand lens.
  Rays: Narrow; numerous.
  Parenchyma: Apotracheal axial parenchyma diffuse-in-aggregate.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood yellowish; heartwood brown or pale brown with purplish streaks; heartwood and sapwood distinctly demarcated. The wood is moderately heavy, is moderately hard, has an unpleasant smell when freshly cut, and is rather oily to touch.

Additional comments

S. pustulata is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

Holarrhena floribunda, Mitragyna stipulosa.

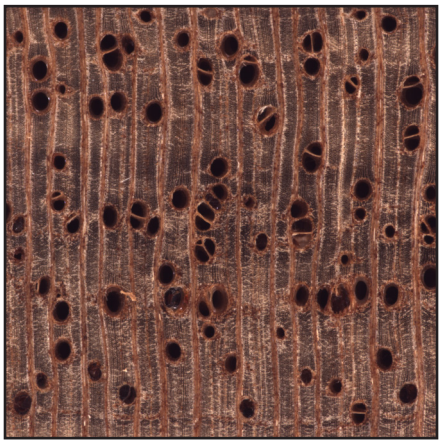
Notes

Tarrietia utilis
(Syn: *Heritiera utilis*)

Malvaceae

Nyankom, Niangon





Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Mostly solitary and in multiples of 2; large diameter; comparatively few to medium abundance.
  Rays: Narrow and medium-wide; few to average abundance.
  Parenchyma: Abundant apotracheal axial parenchyma diffuse and/or diffuse-in-aggregate; paratracheal axial parenchyma narrow vasicentric and lozenge aliform; marginal parenchyma present.
- **Tangential**
  Rays nonstoried, but axial elements sometimes storied, which can be observed with a hand lens.
- **Other characters**
  Sapwood whitish; heartwood pale pink to red-brown; heartwood and sapwood usually distinctly demarcated. The wood is moderately heavy, often with high luster.

Additional comments

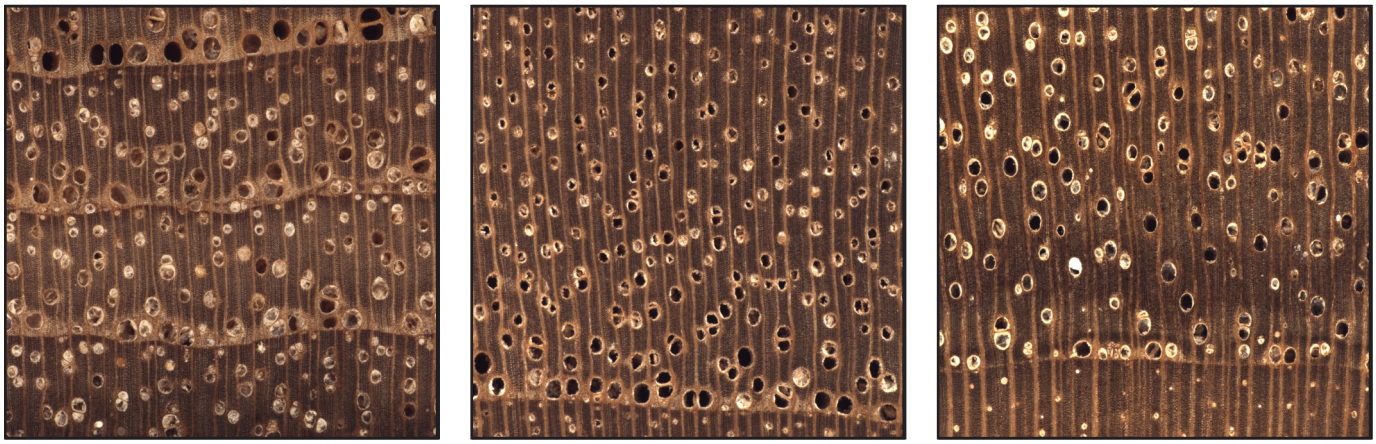
T. utilis is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

Discoglypremna calonerua, Ricinodendron heudelotii.

Notes

Teca, Teak



Anatomical Description of Wood

- **Transverse**
  Porosity: Ring-porous to semi-ring-porous.
  Vessels: Mostly solitary and in radial multiples of 2–4; large diameter in the earlywood, often with tyloses, small diameter in the latewood.
  Rays: Narrow to medium width; medium abundance.
  Parenchyma: Faint paratracheal vasicentric axial parenchyma sometimes present; marginal parenchyma associated with earlywood.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Heartwood golden to medium brown, color darkening with age. The wood is soft to moderately hard, is moderately heavy, and has moderate to low luster. Raw wood has a slightly oily or greasy feel due to natural oils.

Additional comments

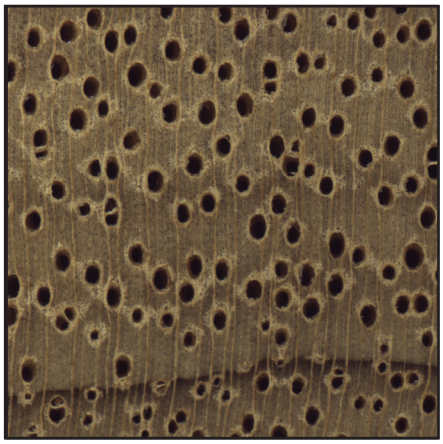
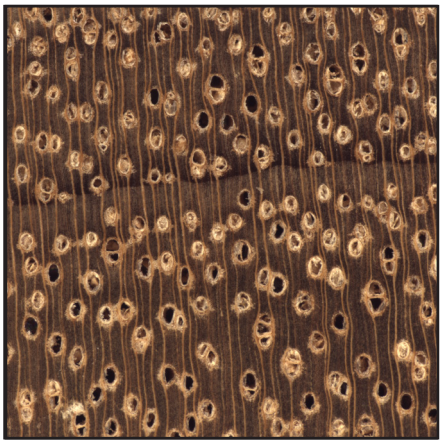
T. grandis is not native to Ghana but is grown in plantations, typically resulting in quite wide growth rings, especially compared with naturally grown material of the same species from within its native range.

Similar woods

Cedrela odorata shows similar ring- to semi-ring-porosity.

Notes

Emire, Idigbo; Ofram, Afara, Limba


Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous; apparent growth rings delineated in part by thick-walled fibers.
  Vessels: Mostly solitary, some radial multiples of 2–3; echelon arrangement common; medium to large diameter; few.
  Rays: Extremely narrow and numerous in *T. superba*, sometimes not visible with a hand lens. Narrow in *T. ivorensis*, medium abundance to abundant but typically easily seen with a hand lens.
  Parenchyma: Paratracheal axial parenchyma vasicentric to winged aliform grading to confluent mostly connecting 2–5 vessels, often found only on one side of the vessel; marginal parenchyma present.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Heartwood yellowish white to pale yellowish brown, sometimes greenish; heartwood and sapwood not clearly demarcated. The wood is moderately light, moderately soft, and low in luster.

Additional comments

T. ivorensis is recorded on the IUCN Red list of threatened species as vulnerable, and *T. superba* is not listed.

Similar woods

Antiaris toxicaria.

Notes

Anenedua, Kyiriwiah

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Solitary and radial multiples of 2–4 common; medium diameter; few.
  Rays: Narrow; numerous.
  Parenchyma: Apotracheal axial parenchyma diffuse-in-aggregate.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood yellowish white; heartwood pinkish; heartwood and sapwood not clearly differentiated. The wood is soft to moderately hard and tends to be moderate to high in luster.

Additional comments

T. didymostemon is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

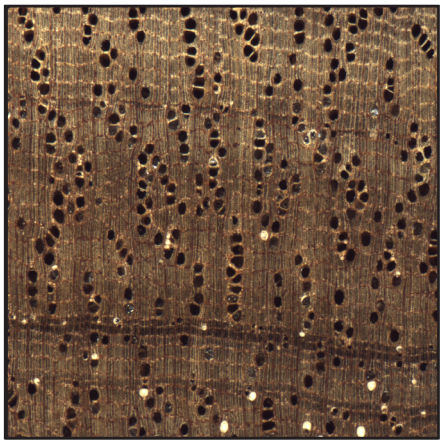
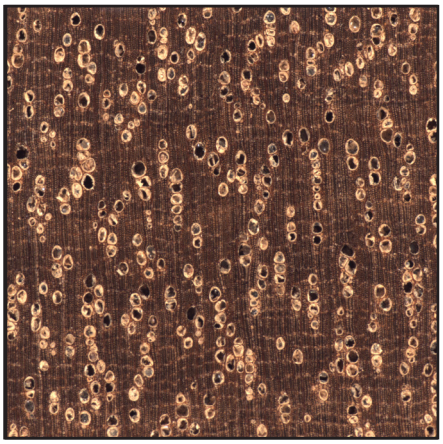
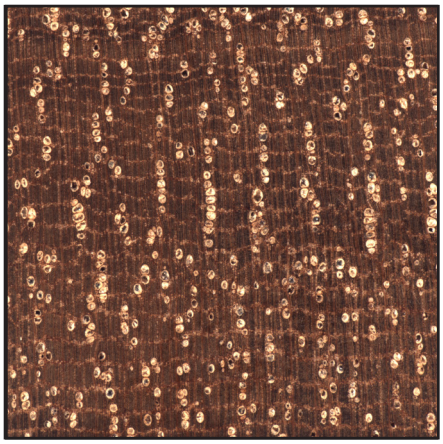
Difficult to discriminate from *Funtumia elastica*.

Notes

Tieghemella heckelii
(Syn: *Mimusops heckelii*)

Sapotaceae

Baku, Makore

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Predominantly in radial multiples of 2–10 (or more), multiples typically in echelon arrangement; medium diameter; few to medium abundance; tyloses common in heartwood.
  Rays: Narrow; numerous.
  Parenchyma: Apotracheal axial parenchyma in long, wavy narrow bands.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Sapwood pinkish white to greyish brown; heartwood pinkish, purplish, or reddish brown; heartwood and sapwood very distinctly demarcated. The wood is medium-weight and moderately hard and often contains a decorative figure in the form of flames or stripes.

Additional comments

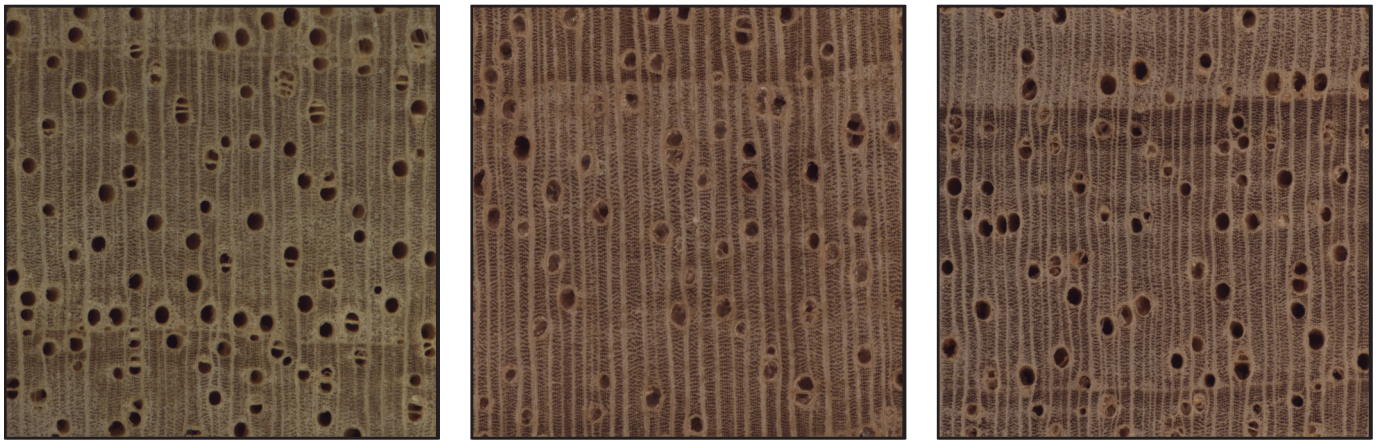
T. heckelii is recorded on the IUCN Red list of threatened species as endangered.

Similar woods

Other Sapotaceae, such as *Chrysophyllum*, *Manilkara*, *Pouteria* spp.

Notes

Wawa, Ayous, Samba, Obeche



Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Mostly solitary and in multilpes of 2–3; medium to large diameter; few; tyloses common in heartwood.
  Rays: Narrow and medium; average abundance.
  Parenchyma: Apotracheal axial parenchyma diffuse-in-aggregate; marginal parenchyma present.
- **Tangential**
  Rays nonstoried, but axial elements are storied, appearing with a lens as faint lines or bands.
- **Other characters**
  Sapwood whitish to pale yellow; heartwood a bit darker; heartwood and sapwood not clearly demarcated. The wood is very light in weight, very soft, and low in luster. Fresh wood has an unpleasant smell, which disappears upon drying.

Additional comments

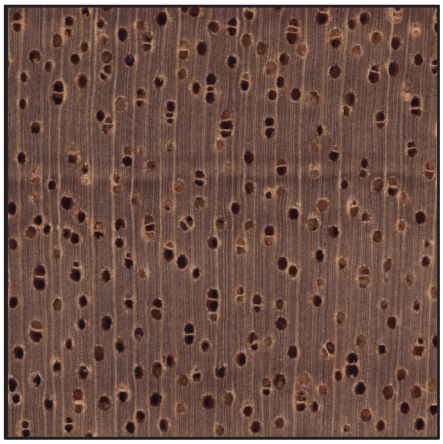
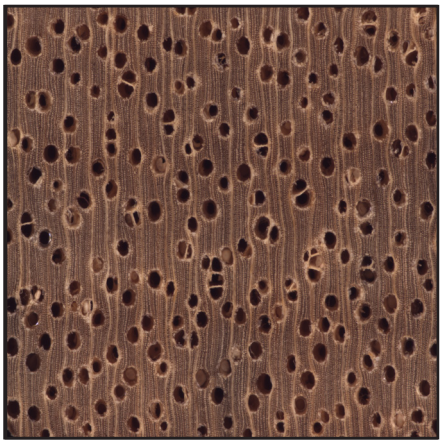
T. scleroxylon is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

Discoglypremna caloneura, Tarrietia utilis.

Notes

Apapaye, Avodiré


Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Solitary and in radial multiples of 2–4; medium diameter; medium abundance; some gums and deposits in heartwood.
  Rays: Narrow; average abundance.
  Parenchyma: Essentially absent.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Heartwood creamy white to pale yellow, darkening to golden yellow on exposure; heartwood and sapwood not clearly demarcated. The wood is light and soft; luster is high.

Additional comments

T. africanus is recorded on the IUCN Red list of threatened species as vulnerable.

Similar woods

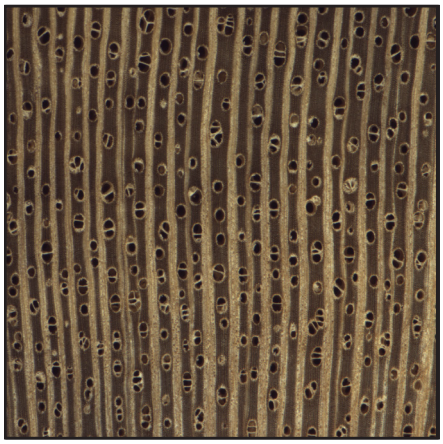
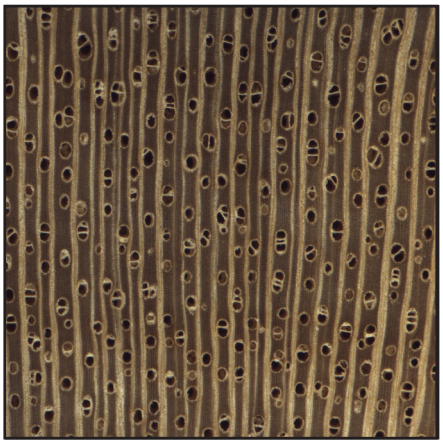
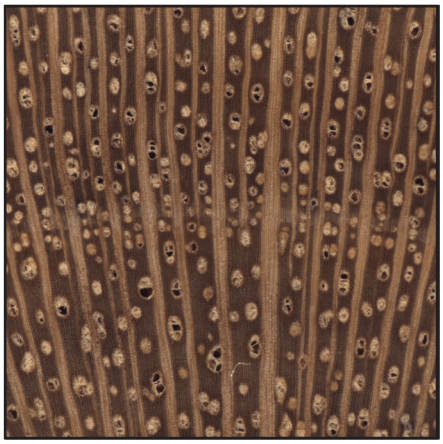
Canarium schweinfurthii.

Notes

Vernonia doniana
(Syn: *V. arborea; V. conferta*)

Asteraceae

Awudiifo-kete, Awonwene

Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Solitary and in radial multiples and clusters of 2–5; small diameter, relatively few.
  Rays: Wide; numerous.
  Parenchyma: Essentially absent.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Heartwood whitish to pale brown; heartwood and sapwood not clearly differentiated. The wood is light in weight and soft.

Additional comments

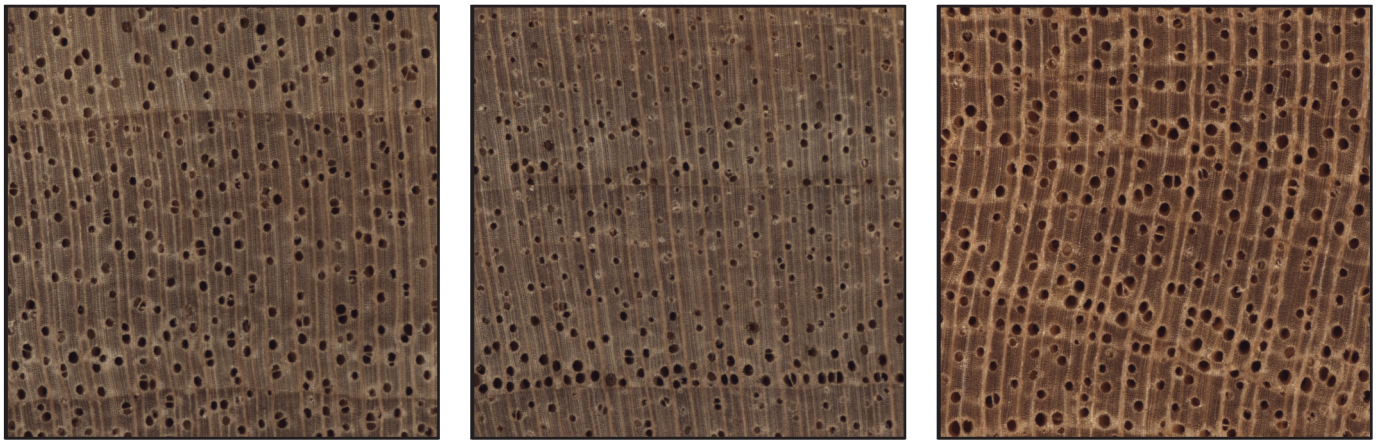
V. doniana is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

Scottellia klaineana.

Notes

Otwentorowa, Abisaa, Supowa, Andofiti



Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous to semi-ring-porous.
  Vessels: Mostly solitary and in multiples of 2–3; medium to large diameter; few.
  Rays: Narrow and medium; average abundance. Widest rays visible to the naked eye.
  Parenchyma: Paratracheal axial parenchyma faintly vasicentric to lozenge aliform; marginal parenchyma common and in association with earlywood vessels when semi-ring-porous.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Heartwood creamy white to pale yellow-brown, darkening on exposure; heartwood and sapwood not clearly demarcated. The wood is low in luster.

Additional comments

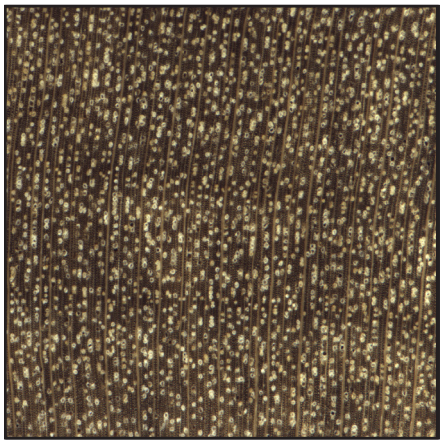
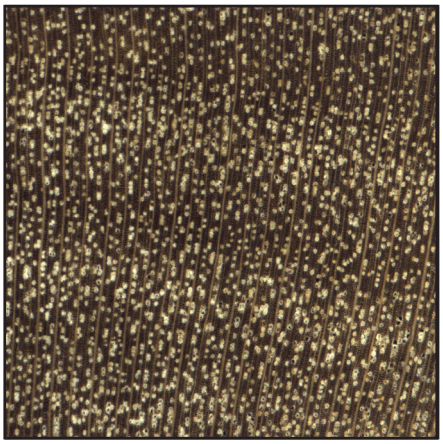
V. micrantha is recorded on the IUCN Red list of threatened species as a species of least concern.

Similar woods

Antiaris toxicaria.

Notes

Foba, Obondai, Ofuruma


Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Mostly in long radial multiples of 2–8 (or more); small diameter; abundant.
  Rays: Narrow and narrow-medium; numerous when considered both sizes of rays.
  Parenchyma: Axial parenchyma essentially absent to faintly apotracheal diffuse-in-aggregate (when present barely visible with a hand lens).
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Heartwood yellowish brown to grey; heartwood and sapwood not clearly demarcated. The wood is soft and light.

Additional comments

V. africana is not recorded on the IUCN Red list of threatened species.

Similar woods

Hymenocardia acida.

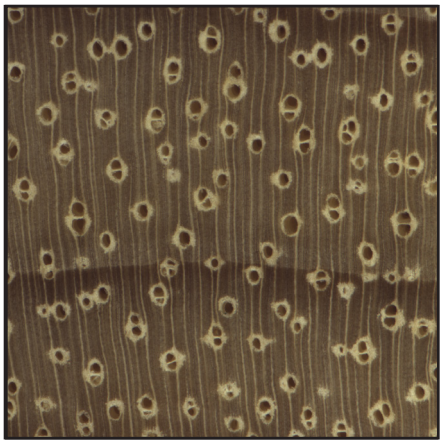
Notes

Zanthoxylum gilletii
(Syn: *Z. macrophyllum*)

Rutaceae

Okuo





Anatomical Description of Wood

- **Transverse**
  Porosity: Diffuse-porous.
  Vessels: Solitary and in radial multiples of 2–3; medium to large diameter; few; colored deposits in heartwood.
  Rays: Narrow; average abundance.
  Parenchyma: Paratracheal axial parenchyma vasicentric to short aliform to confluent connecting few vessels; marginal parenchyma often present.
- **Tangential**
  Rays nonstoried.
- **Other characters**
  Heartwood yellowish to pale brown; heartwood and sapwood not clearly differentiated. The wood is frequently lustrous.

Additional comments

Z. gilletii is not recorded on the IUCN Red list of threatened species.

Similar woods

Anopyxis klaineana.

Notes

8 | Additional information about wood identification

8.1 The limits of wood identification

In using the key and the species description pages, we are sure you noticed that identification of an exact species is rarely possible. This is due in part to the nature of the tools we are using in this manual. A hand lens is a powerful tool for wood identification, but it is not the most powerful method for identification based on anatomical characteristics. The greatest power in wood identification comes with the use of light microscopy in a laboratory with a scientifically valid reference collection (more about reference collections subsequently). Even in such a setting and with a microscope, species-level identification is still not possible by wood anatomy in most cases.

This limit, and it is a profound one, is not a result of a lack of effort on the part of wood anatomy researchers but rather reflects a basic biological truth; species are defined by flowers, fruits, leaves, and other external characteristics. Internal characteristics, such as wood anatomy, often do not vary from one species to another in the same genus, and so species cannot be separated using them. At the time of this writing, there were a number of efforts around the world to use other scientific techniques to identify exact species of wood, and in some cases, to match a specific log, board, or wood product to a stump left behind in the field. Most of these methods depend on either DNA technology or sophisticated techniques in chemistry or spectroscopy. To date, none of these techniques have proved universally reliable, are still costly and time-consuming, and are considered experimental. If and when the day arrives that a technological solution is available to ensure species identification of wood, it is not likely to be equally available in all countries and regions and will probably involve laboratory rather than field analysis. This means that, crude as they may seem, a hand lens and a sharp utility knife are likely to be the tools of choice for field identification of wood for the foreseeable future. You now have a solid foundation in this skill and can expect your skills, if you keep them sharp with practice and careful observation, to be relevant and useful for at least the next decade and possibly much longer.

8.2 The need for scientific forensic expertise to combat illegal logging

Field identification of wood and wood products is the first step in the process of ensuring legal trade and wise use of forest resources, but it is not the only step. Within each country, there is a critical need for one or more scientific centers that specialize in the forensic identification of wood. That is, places that have the resources to provide identifications that meet scientific standards sufficient to be used as evidence in a trial. If stopping a shipment is the first and necessary part of the process, by itself it is not sufficient to enforce the law. To make full use of your new skills, you must work with the appropriate authorities and government agencies in your country to ensure that all evidence needed for a seizure or prosecution is collected and stored correctly. It has been our experience that people at all levels of law enforcement are ready and willing to help you learn the procedures necessary to preserve and maintain evidence for a prosecution. Only by seeing law enforcement through to its conclusion will laws protecting forest resources (or those governing tariffs and taxes) make their best contributions to your forests and your society.

8.3 Building a reference wood collection

Ultimately, scientific wood identification depends on a valid set of known specimens with which unknown specimens can be compared. Most of the specimens shown in this manual were taken directly from institutional wood collections or were compared with specimens in those collections and deemed to be valid specimens. In Ghana, the wood collection of record is maintained by CSIR-FORIG in Kumasi. The need for a large scientific collection at the national level does not mean that you should not have your own small reference collection, maybe with 20 or 50 or 100 specimens representing the woods you see most commonly. Indeed, such a tool is of great value for field wood identification because no one has ever taken a photo that can compete with the information and detail you can observe with your hand lens. If a picture is a worth 1,000 words, a wood specimen is worth 100,000. If there were any cost-effective way to do it, each copy of this manual would include a set of reference specimens for all the species included in the key. Doing such a thing would have made impossible this entire project, so it is incumbent on you to build your own reference collection. Do this patiently, and use the manual to identify each specimen you wish to add to the collection to ensure that you are adding only correctly identified woods. With your new skills, the proper tools, this manual, and a growing reference collection, you will be able to perform your duties more confidently and rapidly.

8.4 Additional wood identification information

Many wood identification references are available in addition to this manual. Many of them are written for professional wood anatomists with specific emphasis on the microscopic identification of wood. These resources, though parts will exceed your current knowledge, may nonetheless prove useful in your work. Other references will be more appropriate for your use as you develop your skills in wood identification. It is important to keep in mind that not all references are of the same quality; some references, even well-known ones, have significant flaws or errors. Subsequently, we list a small selection of resources, as well as some candid comments about the reliability of the information in each.

100 Tropical African Timber Trees

Oteng-Amoako, A.A. 2006. *100 Tropical African Timber Trees From Ghana: Tree Description and Wood Identification with Notes on Distribution, Ecology, Silviculture, Ethnobotany and Wood Uses.* Kumasi, Ghana: Forest Research Institute of Ghana.

This book compiles wood identification features of selected species in Ghana to assist in their identification. It also includes tree identification features; notes on ecology, silviculture, and ethnobotany; and uses of the timber species.

InsideWood

InsideWood. 2004 onwards. Published on the internet. North Carolina State University, Raleigh, NC. (http://insidewood.lib.ncsu.edu/search?2)

This is a tremendously useful resource for wood identification in the laboratory, with a distinct emphasis on light microscopic identification. It incorporates a (usually) complete anatomical characterization of each species in the database, it allows rapid searching, and many of the species it covers are illustrated with a variety of photographs. Despite the emphasis on microscopy, many of the species in the database have one or more images similar in magnification to those in this manual. InsideWood is being updated, improved, and maintained regularly as of this writing, so it continues to improve as a resource.

Hoadley's books

Hoadley, R.B. 2000. *Understanding Wood: A Craftsman's Guide to Wood Technology.* 2nd Ed. Newtown, CT: Taunton Press.

Hoadley, R.B. 1990. *Identifying Wood: Accurate Results with Simple Tools.* Newtown, CT: Taunton Press.

These books provide basic information on the structure, properties, and identification of woods, with a greater emphasis on North American species. The information is clearly presented with high-quality illustrations but emphasizes microscopic rather than hand lens observation of wood for identification.

Textbook of Wood Technology

Panshin, A.J.; deZeeuw, C. 1980. *Textbook of Wood Technology.* 4th ed. New York: McGraw-Hill.

This is a famous but out-of-print college textbook for understanding many aspects of wood technology, including detailed information on wood identification of North American species. The identification keys in the book are of questionable consistency and reliability. Despite the comparative weakness of the keys themselves, the earlier chapters reviewing the scientific literature in wood technology are useful and relatively up-to-date as of the year of publication.

9 | Index of local and trade names

LOCAL NAME	TRADE NAMES	SCIENTIFIC NAMES	PAGE
Abisa		*Vitex micrantha*	121
Aboloobaa	Baphia	*Baphia nitida*	47
Afam		*Parinari excelsa*	100
Afena	Afena	*Strombosia glaucescens*	112
Akasaa	Chrysophyllum	*Chrysophyllum albidum*	57
Akasaa	Chrysophyllum	*Chrysophyllum subnudum*	57
Akata, Onyinakoben	Bombax	*Bombax brevicuspe*	50
Akonkodie	Bombax	*Bombax buonopozense*	50
Akye	Blighia	*Blighia sapida*	49
Ananta	Cynometra	*Cynometra ananta*	65
Apapaye	Avodire	*Turraeanthus africanus*	119
Aprokuma	Antrocaryon	*Antrocaryon micraster*	46
Asanfena	Asanfena	*Pouteria altissima*	105
Asoma	Parkia	*Parkia bicolor*	101
Atabene	Chrysophyllum	*Chrysophyllum perpulchrum*	57
Atibidua	Atibidua	*Hymenocardia acida*	82
Atwea		*Diospyros viridicans*	68
Awiemfosamina	Albizia	*Albizia ferruginea*	40
Awudifo-kete		*Vernonia conferta*	120
Ayan; Bonsamdua	Ayan	*Distemonanthus benthamianus*	70
Baku; Makore	Makore; Baku	*Tieghemella heckelii*	117
Bediwonua	African Canarium	*Canarium schweinfurthii*	52
Berekankum	Manilkara	*Manilkara obovata*	90
Bompagya	Bompagya	*Mammea africana*	89
Bontodee	Anthocleista	*Anthocleista nobilis*	44
Cedrela	Cedrela	*Cedrela odorata*	54
Chienchienga		*Entada abyssinica*	72
Dahoma	Dahoma	*Piptadeniastrum africanum*	104
Danta	Danta	*Nesogordonia papaverifera*	99
Denya	Denya	*Cylicodiscus gabunensis*	64
Duabankye	Eyoum	*Dialium aubrevillei*	67
Dubini	African Mahogany	*Khaya ivorensis*	83
Dubinibiri	African Walnut	*Lovoa trichilioides*	88
Edinam	Edinam	*Entandrophragma angolense*	73
Efoobrodedwo	Utile; Sipo; Sapele	*Entandrophragma utile*	73
Emeri	Emeri	*Terminalia ivorensis*	115
Entedua	Salikounda / Etimoe	*Copaifera salikounda*	61
Esa-fufuo	Celtis	*Celtis mildbraedii*	56
Esa-kokoo	Celtis	*Celtis zenkeri*	56
Esakosua	Celtis; Ohia	*Celtis adolfi-friderici*	56
Fetefre		*Discoglypremna caloneura*	69
Fotie; Hotrohotro	Hotrohotro	*Quassia gabonensis*	108

Funtum		*Funtumia elastica*	75
Gawo/pampenama	Corynanathe	*Corynanthe pachyceras*	63
Gmelina	Gmelina	*Gmelina arborea*	77
Hyedua	Hyedua	*Daniellia ogea*	66
Kaku	Ekki	*Lophira alata*	87
Kokote	Anopyxis	*Anopyxis klaineana*	43
Kokrodua	Afromosia	*Pericopsis elata*	102
Konkroma		*Morinda lucida*	96
Krayie	Rosewood	*Pterocarpus erinaceus*	106
Kroma	Klainedoxa	*Klainedoxa gabonensis*	84
Krumben	African Mahogany	*Khaya anthotheca*	83
Kube	Palm	*Cocos nucifera*	59
Kumanini	Lannea; Kumanini	*Lannea welwitschii*	85
Kumdwie		*Duguetia staudtii*	71
Kuntunkuri	Dry Zone African Mahogany	*Khaya senegalensis*	83
Kusia	Kusia; Opepe	*Nauclea diderrichii*	98
Kwabohoro	Scented Guare	*Guarea cedrata*	78
Kwakuo-bese	Carapa	*Carapa procera*	53
Kwasoro		*Aidia genipaeflora*	39
Kwatafompaboa-nini	Berlinia	*Berlinia grandiflora*	48
Kyenkyen	Chenchen	*Antiaris toxicaria*	45
Kyiriwiah		*Tetrorchidium didymostemon*	116
Mmakube	Borassus	*Borassus aethiopum*	51
Nakwa		*Holoptelea grandis*	81
Ngo-ne-nkyene	Cleistopholis	*Cleistopholis patens*	58
Nyankom	Niangon	*Tarrietia utilis*	107
Obondai; Ofuruma		*Voacanga africana*	122
Odum	Iroko; Odum	*Milicia excelsa*	94
Ofram	Ofram	*Terminalia superba*	115
Ohaa	Ohaa	*Sterculia oblonga*	111
Okoro	Albizia	*Albizia zygia*	40
Okuo		*Zanthoxylum gilletii*	123
Omenewa	African Ebony	*Diospyros kamerunensis*	68
Onyina	Ceiba	*Ceiba pentandra*	55
Oprono	Mansonia	*Mansonia altissima*	91
Otie	Otie	*Pycnanthus angolensis*	107
Otwese		*Memecylon lateriflorum*	93
Pampena	Albizia	*Albizia adianthifolia*	40
Papao	Afzelia	*Afzelia africana*	38
Papea		*Margaritaria discoidea*	92
Papea, Oto oto		*Lonchocarpus sericeus*	86
Penkwa	Candolei; Kosipo	*Entandrophragma candollei*	73
Penkwa	Sapele	*Entandrophragma cylindricum*	73

Potrodom	Potrodom	*Erythrophleum suaveolens*	74
Rubber wood	Rubber wood	*Hevea brasiliensis*	79
Sabaha	Subaha; Abura	*Mitragyna stipulosa*	89
Senya	Senya	*Daniellia oliveri*	66
Sese	Holarrhena; Sese	*Holarrhena floribunda*	80
Sinduro	Alstonia; Emien	*Alstonia boonei*	42
Sorono		*Parkia clappertoniana*	101
Teak	Teak	*Tectona grandis*	114
Tetekon	Limbali; Tetekon	*Gilbertiodendron limba*	76
Tia-butuo		*Scottelia klaineana*	110
Tweneboa	African Cordia	*Cordia millenii*	62
Wama	Ricinodendron	*Ricinodendron heudelotii*	109
Watapuo; Dodowa	Colawood; Watapuo	*Cola gigantea*	60
Wawa	Wawa	*Triplochiton scleroxylon*	118
Wawabima	Wawabima	*Sterculia rhinopetala*	111
Wonton	Wonton	*Morus mesozygia*	97
Yaya	Amphimas; Lati	*Amphimas pterocarpoides*	41